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THE ANNUAL REPORT

OF THE

Agricultural and Horticultural Research Station

(THE NATIONAL FRUIT & CIDER INSTITUTE),

LONG ASHTON, BRISTOL,

1917.

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INTRODUCTION.

The prolongation of the war and the consequent need for the concentration of all effort on work of immediate national importance have, to a rapidly increasing extent, had a marked effect upon the activities of the Institute. The reduction of the scientific staff by the continued absence of Mr. C. T. Gimingham, the Chemist of the Station, who is engaged on special work in the Anti-Gas Department of the Army, and the internment of Dr. Lechmere in Germany, the very considerable call upon the time of the remaining members of the staff made by the various schemes of the Food Production Department of the Board of Agriculture with which the Institute has been concerned, and the constantly increasing labour difficulties have combined to reduce the ordinary research and experimental work very materially. The greatest difficulty has been experienced in carrying out the necessary cultural operations in the fruit plantations and the development of new experimental work there has almost entirely ceased. In the cases of investigations already in progress, where it has been possible to suspend operations for the time being without any further serious detriment than loss of time, this has been done. At the request of the Board of Agriculture the land has been utilised to the maximum degree possible for food production, potatoes and various vegetable crops having been raised by intercropping on all available land. A tribute is due to Mr. H. Locke, the fruit foreman, for the results which he has achieved in spite of severe handicaps in every direction.

There have been no staff changes to note during the year, the temporary arrangements recorded in the last Annual Report for conducting the various branches of work having been continued. All members of the staff have been associated with one or more of the various new schemes concerned with food production or preservation initiated by the Food Production Department, and the opportunities of proceeding with investigations of the usual order on fruit culture, plant diseases and their treatment, and on cider-making have accordingly been limited. The services of the Director have been lent to that Department at its request, and he has been associated with the work of the Horticulture Division of that body since last May, assisting in its general technical work and also in the organisation of the schemes for the preservation of the 1917 fruit crop.

The latter work has now been mainly taken over by the Ministry of Food, and the resources of the Institute have been placed at its disposal and are being freely utilised. Mr. Grove, Mr. Spinks and Mr. Camps have been actively concerned with the schemes for making jelly from cider fruit and the utilisation of apple pomace referred to in detail in this report, and Mr. West has acted as manager of the jelly-making centre established at Long Ashton. Mr. Lees, in conjunction with the Director, undertook the general organisation of the potato-spraying scheme of the Food Production Department for the area included in the Bristol Province, viz., Gloucestershire, Herefordshire, Somerset, Wiltshire and Worcestershire, and devoted the greater part of the summer to rendering assistance to the various local organisations as required. In Long Ashton and district the Institute undertook the spraying of the potato crop for growers, where desired, on the lines of the scheme developed by Mr. Gimingham in 1916, Mr. Spinks being responsible for the arrangements in this case. Mr. Spinks also undertook an enquiry into the supplies of local labour for collecting the apple crop in the West of England, and at the same time organised in the cider-making districts a scheme for ensuring, by drying, the preservation of the supplies of pressed apple pomace not required as cattle food in the fresh state. Mr. West and the Director have assisted in Long Ashton and district in the survey of grass land conducted by the Somerset War Agricultural Committee for the purpose of bringing more land under the plough. In addition to these calls on the time of the staff, numerous miscellaneous questions concerned with food production and preservation have received attention, while Mr. Gimingham's absence has thrown a greater burden of advisory work on the remaining members of the staff.

During the year a matter of the utmost importance affecting the future of the Institute has arisen. On its establishment in 1903, 15 acres of land situated in the centre of Fennswood Farm, Long Ashton, were leased from the Ashton Court Estate for the purposes of experimental work in fruit culture and related subjects. At the time of the association of the Institute with Bristol University 10 acres of this land, on a part of which the permanent buildings have been erected, were purchased; and small amounts of additional land have from time to time been leased until, at the beginning of 1917, a total area of 28½ acres had been acquired. Practically the whole of this is now planted up with fruit of various kinds. After the conclusion of the war, when it is again possible to proceed with field trials and experiments, a considerable additional acreage will be required. Since Fennswood Farm will be vacated by the present tenants in March, 1918, and since any fresh land acquired must be taken from that farm if it is to adjoin the existing plantations, it has been necessary to consider carefully the question of the future

development of the station and its probable needs. As a result an arrangement has been arrived at between Bristol University and the Ashton Court Estate by which the whole farm of 250 acres may be ultimately purchased, if desired, and, in the meantime, provision has been made to take over sufficient land to meet more immediate requirements. The sanction of the Board of Agriculture and the Development Commissioners for this course has been obtained and the Institute will shortly, therefore, have at its disposal for research in fruit culture a total of 53 acres, which should suffice for necessary developments for a few years.

By arrangement with the County Councils of Gloucester and Somerset a series of courses, each of a month's duration, for training girls in the elements of market gardening was held at the Institute from May to August last. In all 36 students attended the courses and subsequently engaged in work on the land. Their work generally at the Institute was highly satisfactory, and many of them should develop into efficient substitutes for male labour in market gardens and on fruit farms. A portion of the laboratory building was given up to provide for their accommodation, since suitable facilities in the neighbourhood could not be found. Mrs. Stock very kindly gave her services as matron for the greater part of the season, Miss Hartley acting in that capacity for the first few weeks. To these ladies hearty thanks are due, the success of the courses being largely contributed to by the excellent manner in which the welfare of the girls was studied by them in every possible way.

For the remainder of the war courses of training in fruit culture for partially disabled officers intending in due course to take up fruit farming are now being arranged at the request of the Board of Agriculture and the Ministry of Pensions. Consequently the girls' courses will be discontinued during the coming year. The training of the officers will extend over a period of two years, the first being spent at Long Ashton, where instruction in the methods of practical fruit culture and in the sciences of chemistry, botany and zoology in relation to that subject will be given, and the second on suitable fruit farms where the commercial side of fruit-growing will be more particularly dealt with. The first course will start in February, 1918.

The following sections of this Report are concerned with some of the various problems which have been under investigation during the year, and also with work which has been undertaken on behalf of the Food Production Department. No reference is made to several investigations in progress which are still in too incomplete a condition to report upon, or to a number of miscellaneous enquiries concerned with problems of immediate urgency which it is not desirable to specify at the present moment.

SINGLE VARIETY CIDERS AND PERRIES, 1916–17.

By Otto Grove.

In the table given below will be found a list of the ciders and perries made during the season 1916–17, with details as to chemical composition and other particulars. The usual notes upon the character of the individual samples are omitted this year.

The average specific gravity of the juices was 1·0514, which is about the normal. The highest specific gravity obtained was 1·059 from Kingston Black, No. 14 in the table, the lowest being 1·044 from Red Cap, No. 5. Taken generally the quality of the ciders was about normal, the majority fairly good with a few very good ones; upon the whole they have kept better than usual, all the samples being in perfect condition after having been kept in bottles for about 12 months. A special feature of this season was a peculiar, not unpleasant, ether-like taste found in many of the samples, this being especially remarkable in Nos. 41 and 43. This might be due to the very cold fermentation temperature during the unusually severe winter. The low temperature would tend to keep the ethers developed during fermentation more in solution than usual. By distilling samples at 60°–70°C. it was found that a certain amount of fruity ethers could be separated.

Sharp Varieties.—In this group the three first were fairly good ciders, somewhat thin and unripe in flavour, but they all improved by keeping. No. 4 was a pleasant, medium brisk cider of quite good quality, better than No. 5, which was rather thin. No. 6 and, especially, No. 7 were very good ciders, the last being particularly fruity and brisk, well adapted for bottling purposes. No. 8 and 9 were good ciders, No. 8 being of good body and fairly sweet. No. 9 was rather thin and very sharp. No. 10 was a very good sharp cider, very suitable for blending with sweet or bittersweet types. Of the Kingston Blacks No. 16 was the best, Nos. 12, 13 and 15 being fairly good samples. Nos. 11 and 14 were rather inferior for the variety.

Sweet Varieties.—The Sweet Alfords were exceptionally good this season, No. 20 especially being very good indeed. The next in merit was No. 19. Of the other sweet ciders No. 21 was fairly

good, full-bodied, but lacking in fruity character. No. 22, which was tried for the first time, was a very good, full-bodied type. No. 23 had a rather crude flavour, but No. 24 was very good with a well-pronounced aroma.

Bitter-sweet Varieties.—No. 25 was dry and bitter, No. 26 fairly good, medium-sweet with a rather bitter after-taste. Nos. 27 and 28 were much alike, good, sound ciders with marked tannin flavour. Nos. 29, 30 and 31 were quite good ciders of moderate body. No. 32 was fairly good, but very bitter; No. 33 fairly good, but lacking in body, and No. 34 was a good cider, very soft with good aroma. The same can be said of No. 35. No. 36 was fairly good; No. 37 very good, but a little thin; and No. 38 of medium quality with a peculiar flavour of straw. No. 39 was good and No. 40 a very good cider with a clean bitter flavour. Nos. 41–43 were fairly good with a peculiar ethery flavour.

The only perry made, No. 44, was very good, although not quite brisk enough.

Ciders made from Mixed Fruit.—The samples No. 45*a* to 54*c* were all made from mixed fruit and treated in different ways. No. 45*a*, the unfiltered sample, was a very hard and unpleasant type; *b* was very similar, but *c* was fairly good. As this mixture was of the quick fermenting type, the racking did not have any effect; only by filtration was it possible so to check fermentation that a fairly good medium sweet cider was obtained. Nos. 46*a* and 46*b* were both quite nice ciders, mild and a little thin, the filtered sample perhaps a little superior to the racked one; they have both kept well and, as this mixture was of the slow fermenting variety, the racking was quite efficient. No. 46*c*, where the juice had been pasteurized and pure yeast added, showed a very slow fermentation and was not filtered until six months after it had been made. The cider had a good clean flavour, but was too sweet; it had kept very well. Nos. 47*a*, *b* and *c* show very markedly the influence of racking and filtering. Sample *a*, which had been left in the cask without filtering or racking, was decidedly inferior to *b* and *c*. In the case of No. 48 the filtered sample was superior to the racked one. The same can be said of No. 49, although the two other samples were quite good. No. 50*a* was very inferior; 50*b* was not good, but better than *a*; *c* and *d* were fairly good ciders, *d* having a cleaner flavour than *c*. No. 51*a* was fairly good, but thin, and 51*b* very similar. No. 51*c* was quite good, sweeter than the preceding. No. 51*d* fermented very slowly; it was similar in flavour to *c* with a trace of cooked taste. No. 52*a* was sharp and rather unpleasant, 52*b* was a good deal better and 52*c* quite good. No. 53*a* was fairly good, and 53*b* similar but decidedly superior. Of Nos. 54*a*, *b* and *c*, *a* was the best of the three, *b* being fairly good and *c* inferior to the other two.

Single Variety Ciders and Perries.

In each case the pomace was pressed immediately after milling, and allowed to ferment naturally in cask, without keeving (unless otherwise stated), until the specific gravity had dropped to 1·025—1·035 in the average case, when the liquor was filtered.

No.	Name of Variety.	District where Grown.	Date of Making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of Fermentation at 28° C.	Special Treatment.	Specific Gravity May, 1917.
	APPLES—Sharp Varieties.								
1	Cap of Liberty	Long Ashton	Nov. 1st	1·049	·82	·17	4·7	....	1·018
2	„ „	Backwell	Nov. 27th	1·046	·82	·28	1·8	....	1·030
3	„ „	South Petherton	„	1·050	·67	·30	1·6	....	1·038
4	Unnamed	Weobley	Nov. 1st	1·058	·52	·28	5·6	....	1·024
5	Red Cap	Berrow	Nov. 11th	1·044	·82	·10	2·3	....	1·031
6	Unnamed	Chudleigh	Nov. 27th	1·053	·53	·13	2·9	....	1·025
7	Butter Box	Newton Abbot	Nov. 1st	1·052	·59	·15	2·5	....	1·035
8	Teign Harvey	„	Oct. 31st	1·052	·60	·30	1·7	....	1·036
9	Bickington Grey	„	Nov. 1st	1·055	1·13	·24	3·5	....	1·033
10	Frederick	Dingestow	Oct. 30th	1·052	1·12	·07	2·0	....	1·030
11	Kingston Black	Ledbury	Nov. 17th	1·053	·51	·33	3·5	....	1·024
12	„ „	Hereford	Oct. 24th	1·058	·53	·20	2·8	....	1·031
13	„ „	„	Nov. 3rd	1·059	·58	·20	3·4	....	1·034
14	„ „	„	Nov. 20th	1·059	·58	·17	3·5	....	1·024
15	„ „	Martock	Nov. 27th	1·049	·50	·16	1·7	....	1·030
16	„ „	Hereford	Oct. 31st	1·052	·58	·18	2·8	....	1·025
	Sweet Varieties.								
17	Sweet Alford	Long Ashton	Nov. 1st	1·053	·23	·15	3·3	....	1·021
18	„ „	Chudleigh	Oct. 31st	1·052	·32	·15	2·8	....	1·025
19	„ „	Newton S. Cyres	Nov. 1st	1·050	·34	·18	2·6	....	1·031
20	„ „	Newton Abbot	„	1·053	·24	·17	2·4	....	1·032
21	Slack-ma-Girdle	„	Nov. 2nd	1·052	·29	·14	3·2	....	1·030
22	Hancock's Seedling	Milverton	Nov. 20th	1·054	·27	·17	3·9	....	1·026
23	Truckle	Martock	Nov. 27th	1·051	·25	·15	2·8	....	1·023
24	Sheep's Nose	„	Nov. 1st	1·046	·24	·19	8·0	....	1·015

	BITTERSWEET VARIETIES.									
25	Jersey	Martock ..	..	Nov. 1st	1·047	·24	·25	6·6	....	1·017
26	Tom Putt ..	Chudleigh ..	..	Oct. 30th	1·053	·30	·22	2·8	....	1·022
27	Strawberry Norman	Long Ashton	..	Nov. 2nd	1·049	·43	·37	7·1	....	1·020
28	„ „ ..	Weobley ..	..	Oct. 30th	1·053	·31	·44	7·6	....	1·022
29	Pocket Apple ..	Newton Abbot	..	Oct. 24th	1·054	·24	·37	3·6	....	1·025
30	Cummy Norman	Weobley ..	..	Oct. 30th	1·058	·30	·32	5·3	....	1·024
31	„ „ ..	Nunnington ..	..	„	1·055	·27	·29	3·1	....	1·028
32	Medaille d'Or ..	Long Ashton	..	Nov. 2nd	1·056	·32	·59	8·1	....	1·026
33	Chisel Jersey ..	„ ..	..	„	1·051	·26	·29	4·1	....	1·023
34	Royal Wilding ..	Byford ..	..	Nov. 3rd	1·057	·21	·29	4·5	....	1·027
35	Cherry Norman ..	Hereford ..	..	Nov. 1st	1·052	·29	·34	3·6	....	1·024
36	Hangdown ..	Bow	..	Oct. 24th	1·054	·17	·33	4·3	....	1·023
37	White Jersey ..	Long Ashton	..	Sept. 26th	1·047	·20	·18	7·5	....	1·024
38	Horner	Milverton ..	..	Nov. 3rd	1·053	·17	·25	2·7	....	1·024
39	Royal Jersey ..	Martock ..	..	Oct. 30th	1·052	·21	·48	3·3	....	1·029
40	Chisel Jersey ..	South Petherton	..	Nov. 27th	1·058	·26	·50	2·2	....	1·038
41	White Norman ..	Weobley ..	..	Oct. 30th	1·052	·23	·40	3·1	....	1·031
42	„ „ ..	Byford ..	..	Oct. 24th	1·054	·20	·37	2·4	....	1·029
43	Newton Jersey ..	Newton S. Cyres	..	Oct. 30th	1·055	·39	·42	2·4	....	1·034
	PERRY.									
44	Unnamed	Byford ..	..	Nov. 20th	1·043	·44	·11	3·1	....	1·031
	CIDER MADE FROM MIXED FRUITS.									
45*a*	Mixture	Long Ashton	..	Oct. 18th	1·049	·62	·21	2·4	Not filtered or racked	1·004
45*b*	„	„ ..	..	„	„	„	„	„	Racked	1·006
45*c*	„	„ ..	..	„	„	„	„	„	Filtered	1·021
46*a*	„	Bow	..	Oct. 24th	1·053	·20	·32	3·0	Racked	1·022
46*b*	„	„	..	„	„	„	„	„	Filtered	1·023
46*c*	„	„	..	„	„	„	„	„	Juice heated to 45–50°C. for 1 hour and added yeast No. 7. Filtered	1·032
47*a*	Mixture	Taunton ..	..	Nov. 1st	1·050	·36	·19	6·1	Not filtered or racked	1·005
47*b*	„	„ ..	..	„	„	„	„	„	Racked	1·021
47*c*	„	„ ..	..	„	„	„	„	„	Filtered	1·023
48*a*	„	Martock ..	..	„	„	·30	·35	5·0	Racked	1·022
48*b*	„	„ ..	..	„	„	„	„	„	Filtered	1·024

Single Variety Ciders and Perries—*continued.*

No.	Name of Variety.	District where Grown.	Date of Making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of Fermentation at 28° C.	Special Treatment.	Specific Gravity May, 1915.
49*a*	Mixture	Chudleigh	Nev. 1st	1·053	·46	·20	3·7	Not filtered or racked	1·022
49*b*	„	„	„	„	„	„	„	Racked	1·026
49*c*	„	„	„	„	„	„	„	Filtered	1·026
50*a*	„	Morchard Bishop ..	Nov. 2nd	1·049	·28	·13	4·8	Not filtered or racked	1·003
50*b*	„	„ „ ..	„	„	„	„	„	Racked	1·018
50*c*	„	„ „ ..	„	„	„	„	„	Filtered	1·020
50*d*	„	„ „ ..	„	„	„	„	„	Juice heated to 50°C. for 1 hour and added yeast 37. Filtered	1·023
51*a*	„	Martock	Nov. 11th	1·047	·42	·27	3·7	Not filtered or racked	1·021
51*b*	„	„	„	„	„	„	„	Racked	1·022
51*c*	„	„	„	„	„	„	„	Filtered	1·024
51*d*	„	„	„	„	„	„	„	Juice heated to 60°C. for 10 minutes and added yeast 37. Filtered	1·028
52*a*	„	Dingestow	Nov. 11th	1·052	·65	·25	4·1	Not filtered or racked	1·019
52*b*	„	„	„	„	„	„	„	Racked	1·024
52*c*	„	„	„	„	„	„	„	Filtered	1·025
53*a*	„	Martock	Nov. 21st	1·045	·52	·22	3·1	Filtered	1·026
53*b*	„	„	„	„	„	„	„	Juice heated to 50°C. for 1 hour and added yeast 7. Filtered	1·029
54*a*	Cap of Liberty Truckle .. Dabinett	„	Nov. 28th	1·047	·46	·21	3·6	Apples milled and pressed together	1·022
54*b*		„	„	1·049	·51	·25	3·5	Apples milled together and macerated 24 hours before pressing	1·021
54*c*		Long Ashton ..	„	1·050	·46	·24	3·7	Juice of Cap of Liberty macerated 24 hours with pomace of the two other sorts before pressing	1·022

A ROPY CIDER BACILLUS.

By Otto Grove.

During the summer some samples of ropy cider were sent in for examination from the Tewkesbury district. The cider was slightly cloudy when received, and this cloudiness increased greatly until, after being kept for about six months, the liquid was nearly milky with a stringy deposit. This deposit consisted principally of different kinds of bacteria, of which the predominating types were a small rod bacillus and acetic bacteria. The usual yeast cells and Torulas were present in smaller quantity than in normal ciders. When the bottles were shaken the deposit formed strings in the liquid, which poured like oil. The aroma of the cider was of a pronounced acetic character, and the flavour acetic and peculiar. The specific gravity was 1.001 ; the acid (determined as malic acid) ·90 per cent. ; tannin ·08 per cent. ; and alcohol 4·02 per cent. by weight.

A number of organisms capable of producing ropiness in cider have been recently described by Kayser. These were isolated from various French ciders. Hitherto no satisfactory case of any organisms producing ropiness and occurring in English ciders has been recorded : but in the case of the samples now under consideration a bacillus causing the ropiness was ultimately isolated and had the following general characters :—

In neutral bouillon after 24 hours at 25°C. : A small rod, rather irregular in size ; most common measurements 1·5 to 2·5μ by ·3 to ·5μ ; often in twos and in short chains. Revolving motility in a few individuals. Involution forms not uncommon.

In 3–4 days old cultures a number of larger rods were forming, and the involution forms were increasing, many showing branched types.

Spores have not been observed.

The bouillon shows very slight cloudiness after 24 hours and is after 48 hours cloudy with a small deposit, which forms strings when shaken up. Best development occurred in neutral and +1·5 bouillon ; less in —1·5 bouillon. At room temperature development is slower. The organism grows well in yeast-water with added glucose ; no development occurs in malt extract.

In +·5 bouillon gelatine plates : no visible development after

24 hours. After 48 hours small, white, uncharacteristic colonies. After four days colonies on surface about 5mm. broad, raised, smooth-edged, bluish-white in transparent light. Deep colonies very small. Slow liquefaction takes place; after two weeks the surface colonies have sunk a little and are seen as smooth-edged spheres surrounded by a 2mm. broad area, where the gelatine is liquefied; there is no growth in the liquefied area.

Bouillon gelatine stab: After four days 2mm. broad, smooth-edged, raised, glistening, dull-white development on surface a little sunk in middle; sparse uniform growth along stab. After 14 days, colony 3mm. broad with slight crateriform liquefaction.

Gelatine slope: After four days 1½mm. broad growth with slightly raised and undulating edges. After 14 days the growth has caved in to a depth of 3mm. and a certain amount of liquid with a white, flocculent, slimy deposit has collected at the bottom of the tube.

In +·5 Agar-bouillon plates kept at 25°C.: Colonies just visible after 24 hours. After four days surface colonies measure 1–1½mm. and are smooth-edged, round, raised, glistening white. Deep colonies small, white.

Agar-bouillon stab: shows after four days at 25°C. a 3mm. broad growth on surface of same appearance as above; white, uniform growth along stab.

On sloping bouillon-agar: there is formed after four days at 25°C. a 2mm. broad growth with raised slightly undulating edges of a greyish-white colour.

In fermentation tubes with bouillon plus 2% saccharose, glucose or lactose a vigorous growth with cloudiness, and a white, stringy deposit is formed in the open area; the liquid is clear and no gas development occurs in closed arm.

Development of acid: 10cc. of a 2% saccharose-bouillon culture kept at 25°C. for 14 days required ·8cc. N/10 soda for neutralisation. Glucose- and lactose-bouillon cultures under same conditions required 1·4cc. and ·6cc. N/10 soda respectively.

Indol formation.—No reaction for Indol after 10 days at 25°C.

Influence of organic acids.—To find the influence of organic acids upon the bacillus, different proportions of malic, tartaric and citric acid were added to two tubes containing 2% glucose in yeast water and these were kept at 25° together with control tubes with no acid added. The results were the following:—

Malic Acid:

	After 1 week.	After 3 weeks.	After 6 weeks.
Tubes with ·2%	Some growth		
„ „ ·4%	Small growth		
„ „ ·6%	Very small growth	Same as after 1 week	Same as after 1 week
„ „ ·8%	No growth		
„ „ 1%	No growth		

Tartaric Acid :

	After 1 week.	After 3 weeks.	After 6 weeks.
Tubes with ·2%	Some growth		
„ „ ·4%	Small growth		
„ „ ·6%	Very feeble growth	Same as after 1 week	Same as after 1 week
„ „ ·8%	No growth		
„ „ 1%	No growth		

Citric Acid :

Tubes with ·2%	Some growth	Same as after 1 week	
„ „ ·4%	Small growth	Ditto	Same as after 3 weeks
„ „ ·6%	Very small growth	Ditto	
„ „ ·8%	No growth	Very feeble growth	
„ „ 1%	No growth	Very feeble growth	

Control Tubes : Very strong slimy growth.

The organic acids have consequently a pronounced preventative action upon the development of this organism, as had been anticipated, because ropiness is a disorder generally found in ciders of the sweet type, which contain only a small initial proportion of acid.

Ropiness is a disorder that is quite common in ciders in some districts, whereas it is hardly known in other districts. This is very probably due to the character of the mixtures of apples used; that is to say, if the mixture used contains a sufficient proportion of sharp apples to bring the initial acidity up to ·5 per cent. or more, there is not much danger of ropiness setting in. If, on the other hand, the mixture consists of sweet and bittersweet apples only or of such fruit mixed with sharps in insufficient quantity the disorder may turn up. Ropiness is in most cases fairly easy to cure; the method to use has been mentioned in an earlier report.

The disorder is sometimes called ropiness and sometimes oiliness, the two names denoting either two stages in the same disease, oiliness being the early stage and ropiness being used when the disorders is so far advanced that the whole liquid has a distinctly ropy character, or the term oiliness indicating a light attack and ropiness a bad attack.

A NOTE ON CIDER VINEGAR.

By Otto Grove.

Several enquiries have been received during the year as to the value of cider vinegar as a substitute for malt vinegar. Supplies of the latter are becoming short owing to the war, and the provision of adequate supplies of some other form of vinegar may become necessary. Cider vinegar is a satisfactory substitute and could be produced in considerable quantity if the necessity arose. A few notes on its method of manufacture are therefore given.

When cider is exposed to the influence of the air it goes quickly hard or sour and gradually turns into vinegar. It has been mentioned in earlier reports that this transformation is due to the action of bacteria, which by means of the oxygen in the air transform the alcohol contained in the cider into acetic acid, acetic acid being the chief constituent of vinegar. Thus cider-vinegar is the final product of a disorder known as acetification. To produce vinegar from apple juice two separate fermentations are necessary, namely, first the alcoholic fermentation brought about by a yeast, by which the sugars in the apple juice are fermented into alcohol and carbonic acid gas, and secondly the acetic fermentation caused by bacteria, by which the alcohol is oxidised into acetic acid. Finally, if the vinegar is left for a long time exposed to the air the acetic acid is gradually transformed into carbonic acid gas.

The vinegar made from cider will contain all the constituents of the cider resulting from the alcoholic fermentation of the apple juice with exception of the alcohol, which is more or less completely turned into acetic acid. To make a good vinegar from cider it must be made from pure apple juice fermented to dryness and containing 4 to 5 per cent. of alcohol by weight. By the acetic fermentation the alcohol should theoretically be transformed into acetic acid in the proportion 46 parts of alcohol to 60 parts of acetic acid. In practice this proportion cannot, however, be maintained, partly because a little alcohol always remains in the vinegar, partly because of evaporation during the fermentation. The proportion to expect would be as about 4 to 5, so that a cider containing 4 per cent. by weight of alcohol should give a vinegar with 5 per cent. of acetic acid.

To make vinegar from cider the following three conditions are necessary: (1) The presence in the cider of the acetic ferment; (2) Access of air; and (3) Temperature of 65°–85°F. The acetic ferment is present in all unpasteurized ciders, and one has only to leave a bottle open for some time at a convenient temperature to see it develop as a thick, leathery film on the surface of the liquid. This film consists of a small rod-bacterium (*Bacterium xylinum*). To get a quick development of this "vinegar plant" a little vinegar can be added to the cider placed in an open vessel at a temperature of about 75°F.

A small vinegar-making plant for household purposes can easily be constructed in the following way. An ordinary cask with a capacity of, say, 6 gallons, is filled a little over halfway with a dry, completely fermented cider. To the cider can be added a little good vinegar. The cask is placed upon its side, provided with a wooden tap and a hole of about one inch diameter is bored in each end; one of the holes about one inch over the surface of the liquid in the cask, the hole in the other end close to the top. In the bunghole is inserted a small glass funnel, to which is attached a piece of rubber tubing dipping into the cider. To prevent access of the so-called vinegar flies, which deposit their eggs in the vinegar, the holes and the funnel are covered with a little fine gauze (cheese-cloth). The cask is placed in a warm room, and the vinegar making will soon start.

After about two months a sample is taken out through the tap, and if the temperature of the room has been sufficiently high, the vinegar will be ready for consumption. If the room has not been warm enough the process will take longer time, *e.g.*, 4 to 6 months. Thus vinegar can be made continuously by replacing the vinegar drawn off with dry cider poured in through the funnel.

With an apparatus constructed as above some very good cider vinegar has been made at the Institute. The vinegar was made from a dry cider containing 4·5 per cent. of alcohol by weight. It was perfectly clear when drawn from the cask, but after some time it became cloudy in bottles. This cloudiness can be overcome by storing the vinegar in closed vessels for some months and racking or filtering. If the vinegar is wanted quickly for bottling, the easiest way to prevent cloudiness setting in is to pasteurize the bottled vinegar by placing the bottles in a waterbath or steriliser, which is slowly heated to a temperature of 140°F. and kept at that temperature for 15 minutes. Cloudy vinegar can also be cleared by filtering or by first adding a clearing agent such as milk, which is used in the proportion of $\frac{1}{4}$ to $\frac{1}{2}$ per cent., *i.e.*, $\frac{1}{4}$ to $\frac{1}{2}$ gallon of milk per 100 gallons of cider. Vinegar prepared upon these lines has been used successfully for pickling purposes.

If it is desired to make vinegar from cider on a large scale a more

elaborate apparatus is wanted of a similar construction to the vinegar-makers used in malt-vinegar factories, or as used for making vinegar from wine. This apparatus generally consists of a cylindrical wooden vat placed upon its end with two perforated wooden discs placed with an interval of varying height, the one above the other, near the top of the vat. Between the two discs is placed a layer of coarse wooden shavings or other similar material presenting a large surface. In the holes of the upper disc are often placed short lengths of cord hanging down in the layer of shavings, so as to distribute the liquid as evenly as possible. The vat has a certain number of air holes, so as to permit the air free access, and is kept in a warm room. The liquid to be acetified is pumped in over the top disc and slowly spreads over the wooden shavings, where it is exposed to the influence of the air, and the process of acetification soon starts. The acetified liquid is drawn out from the bottom of the cask and again pumped into the top of a vinegar-maker, and this process is repeated until the vinegar has the desired strength, which is usually from 4 to 6 per cent. of acetic acid. In the first instance the vinegar-maker is generally started with a pure culture of the acetic ferment. With an apparatus as outlined in the above it is possible to transform cider into vinegar at a quick rate.

NOTES ON THE FRUIT BLOSSOM BACILLUS

By Otto Grove.

In earlier reports mention has been made of the discovery of a bacillus causing a serious disease of fruit blossom—pear blossoms and fruit spurs of pear trees being particularly affected. It has been proved that this bacillus is carried on to the flower, where the disease generally starts on the receptacle, by the aid of insects. It has been reported earlier that this bacillus was found occasionally in the soil, and a series of experiments was carried out last spring to ascertain whether it was so common in the soil that it could be taken for granted that the infection was carried by insects from the soil on to the flowers.

Samples were taken during the first four months of the year from different places in the fruit plantations, vegetable plots, cider orchard and arable land at the Research Station. The samples were taken both at the surface and 6 inches below the surface. The method adopted was to shake a small lump of soil with 7–8cc. of sterilised water and make plate cultures in a medium consisting of 25cc. of malt extract (Sp. Gr. 1·050), ·5 gram potassium phosphate, ·1 gram magnesium sulphate, and 50 grams gelatine in 500cc. of distilled water. This medium is very favourable to the growth of the fruit-blossom bacillus. The following were the results :—

On 36 plate cultures in	January : one colony only found.
,, ,, ,, ,,	February : no colonies.
,, ,, ,, ,,	March : no colonies.
,, ,, ,, ,,	April : thirteen colonies found.

From this it appears that the bacillus is fairly common in the soil in April, but not earlier in the year.

During an investigation for another purpose, a bacillus which was identified as the one causing the fruit blossom disease was isolated from the root of a cabbage plant ; and a series of examinations of the bacterial growth upon the roots of different plants was subsequently carried out during the winter. This examination showed that the bacillus in question is commonly found adhering to the roots of many different plants.

The examination was carried out in the following way: surface and deep roots were taken with sterile forceps and placed upon the surface of solidified gelatine plates made with the medium given above. Plates were also made from sterile water, in which parts of the roots had been shaken up. The plate cultures were left at a temperature of 8–10°C.

The roots of the following plants were examined: Cauliflower, broccoli, Brussels sprouts, several varieties of cabbage, leeks, celery, strawberry, turnip, lettuce, tomato and grass. It was remarkable to observe that after 3 to 4 days an abundant growth of a bacillus, having the same easily recognisable characters as the fruit blossom bacillus, developed in all of a great number of plate cultures. This bacillus was present on the roots of all the plants mentioned in larger or smaller quantities, and in many cases very nearly a pure culture of the organism was obtained, only a few colonies of moulds and other kinds of bacteria developing. As an example the results can be given for the plate-cultures from the roots of a cabbage plant. After 3 days at a temperature of 8–10°C. small, greyish-white colonies were observed along the roots placed upon the surface of the gelatine. The fourth day the colonies had grown to a size of 2–3mm. They were round, with smooth, clear-cut edges, the gelatine being completely liquefied with a white flocculent deposit. The colonies soon grew together and formed a band of liquid gelatine about 10mm. broad along the roots. In 8 days the whole of the gelatine was liquefied and smelt strongly of ammonia. More colonies were formed from the surface roots of the plant than from the deeper roots. Only very few colonies of other organisms developed upon the plate-cultures.

A piece of fine root, about one inch long, with the adhering soil was then well shaken up in 8cc. of sterile water, and from this plate cultures were made. After 3–4 days all the plates showed a great number of colonies of the bacillus and very few colonies of other organisms.

The characters of this bacillus correspond very closely with those of the fruit blossom bacillus, and in view of the recent publication of Miss E. M. Doidge's paper on a South African fruit blossom bacillus they may be given in detail for comparative purposes.

Description: A very motile rod bacillus with rounded ends; mostly in pairs, 2–4μ × ·5–·8μ in dimension. Flagellæ lophotrichic, two or more in number, four to five times as long as the cells themselves. The organism stains well, especially with gentian-violet. Spore formation has not been observed, optimum temperature 18°C.

In bouillon at 16–18°*C.*: After 24 hours in neutral bouillon slight cloudiness and thin ascending film. In +1·5 bouillon the same but the film a little stronger. In —1·5 bouillon very slight cloudi-

ness and no film. After 3 days, best development in +1·5 bouillon, thin, ascending film pronounced with ring sticking to tube, cloudiness and some deposit. After 8 days well developed film with wrinkled surface, liquid clouded with small white deposit and a feeble green fluorescence, especially in neutral bouillon. Both neutral and +1·5 bouillon alkaline to phenolphthalein.

Bouillon gelatine (+·5): In plate cultures colonies not visible after 24 hours: after 3 days surface colonies liquid, circular, smooth-edged, 3–5mm. in diameter. Content of colonies has a feeble green fluorescence, opaque with whitish deposit in middle. Deep colonies very small and uncharacteristic. After one week gelatine completely liquefied with smell of ammonia and alkaline reaction.

Gelatine stab: After 24 hours small liquefied crater with white deposit, greyish white development along stab; after 3 days, crateriform liquefaction about 10mm. broad, 3mm. deep, no liquefaction along stab; liquid opaque with white granular deposit in middle, green fluorescence. Half of the gelatine in tube liquefied in 6 days.

Gelatine slope: After 24 hours: ·5–1mm. broad, greyish white finely granulated streak with starting liquefaction, drops of liquid at the bottom of the tube. After 3 days a groove 6mm. broad and 3–5mm. deep, smooth-edged, greenish fluorescence, liquid at bottom of tube with floculent white deposit.*

Bouillon agar: Plate-cultures show small, bluish white colonies after 48 hours, spreading on surface after 3 days, smooth-edged, raised. Deep colonies very small.

Agar stab: Raised growth on surface about 2mm. broad, after 48 hours, good development along stab.

Agar slope: Thin, whitish development, 1mm. broad. After some days growth spreads a little and edges get undulated.

Milk cultures give good growth; no coagulation had taken place after 8 days.

On potato: After 24 hours at room temperature, thin, raised growth of a white colour with smooth edges. After 48 hours 1–2mm. broad, yellowish. In old potato cultures the colour changes to brown. Grows well in sterilised soil.

The bacillus produced involution forms quite readily, especially when cultivated at 25°C. and in potato cultures.

In fermentation tubes: Neutral bouillon plus 2% saccharose, glucose or lactose show similar development. After 24 hours slight cloudiness in short arm, long arm clear. After 3 days short arm cloudy with deposit, no development or gas formation in long arm.

* Growth in the malt extract gelatine mentioned earlier always has a pronounced green fluorescence.

Production of Ammonia: After 7 days at room temperature in neutral bouillon 100cc. when distilled with magnesium oxide gave ·005 grams of ammonia.

In the determination of these characters, given cultures of the fruit blossom bacillus and the bacillus isolated from the roots, were used side by side and showed no material difference; the only sign of difference observed was that in some cases the root bacillus gave a feeble reaction for Indol, which has never been obtained with cultures of the fruit blossom bacillus.

As this bacillus was found so commonly adhering to the roots of many different plants it was thought possible that it might have some action, favourable or otherwise, upon the growth of the plants, and some experiments were carried out in that respect.

Pots with soil sterilized under 15lbs. steam pressure for 2 hours were seeded with sterile seeds of several brassicas. To one set of pots were added cultures of the bacillus; another was kept as a control. The seed germinated in nearly all cases quicker in the inoculated pots than in the controls, especially during the first 10 days. There was quite a remarkable difference, the size of the seedlings being as 2 to 1, and the soil of the inoculated pots was swarming with the bacilli in vigorous development.

Some experiments in the open were carried out with most of the common vegetables. Each kind of seed being sown in four rows, of which the two were watered when sown and later on once a week for five weeks with cultures of the bacillus, the two rows being kept as controls. These experiments did, however, not give any appreciable results, possibly owing to the fact that the soil in this case was naturally adequately supplied with the organisms in sufficient abundance.

DAMPING-OFF AND COLLAR ROT OF TOMATOES.

By G. T. Spinks.

Among the diseases to which tomatoes grown under glass are subject is a "damping-off" or "collar-rot" which has hitherto received little attention, though it is of wide-spread occurrence and sometimes causes serious losses in tomato houses. In some cases quite young seedlings which are only just showing their first rough leaves wilt and collapse, the stem being weak and shrivelled at the ground level. This is the "damping-off" stage of the disease. At other times the "collar rot" is met with, this being a shrinkage and discolouration of the stem at the collar followed by the collapse of the plant. Young plants several inches or almost a foot in height may be killed by this "collar rot," though attacked plants sometimes recover and grow into apparently healthy plants showing only a slight shrinkage and discolouration at the collar.

Serious attention was given to this matter last season when a grower found that whole batches of seedlings and whole houses of older plants were being killed by this disease. Specimens of the attacked plants of various ages were then examined and in all cases the tissues of the stem at the collar were found to contain the mycelium of a fungus. It may be as well to state here that the same fungus was found in diseased plants of all ages, the difference between the "damping-off" and the "collar rot" being due only to the different ages at which plants are infected. There is thus only one disease in question and most of the following observations apply to attacked plants of all ages.

The fungus mycelium was apparently that of a *Phycomycete*, but no form of fructification by which it could be identified was found either on the surface of the plant or within the tissues. When portions of diseased stem are placed in water, however, in the course of one or two days sporangiophores bearing sporangia grow from the stem into the water. These sporangia are minute oval bodies which eventually burst and liberate still smaller spores which swim about in the water. The fungus is evidently a *Phytophthora*, a close relation of the fungus which causes "Potato

Disease," but so far the actual species has not been identified as no form of fructification except the sporangia has been found. It has not yet been found possible to grow the fungus on artificial or sterilized media and thus to obtain a pure culture.

Healthy seedlings were planted in clean soil with pieces of diseased plants in contact with the stem just below the surface of the soil, and in three or four days the seedlings "damped-off" and on examination were found to be infected with the same fungus. Samples of soil obtained from a tomato house in which practically all the plants had been killed a few weeks before (in February) were then put in seed boxes. Several batches of very young seedlings were planted in these boxes and about half of them were attacked and killed within a week. Usually, if plants were not attacked within this time of being planted they did not become infected later, probably because the sources of infection in the soil were only local. At the beginning of April the boxes of infected soil were planted with healthy seedlings of various ages, the youngest having no rough leaves while the oldest were five or six inches high and had five or six rough leaves. Most of the youngest seedlings were quickly killed, while a few of the oldest plants were attacked at the collar, though not killed; and about half of the plants of intermediate age were killed. Later in the year seedlings planted in the same boxes of infected soil did not become diseased. This may be due to the soil having been allowed to get too dry, thus killing the source of infection in the soil, or to the fungus in the soil having a resting period and being inactive at this time of the year. Both these experiments and the experience of growers show that the fungus is most active and causes most damage in the first three or four months of the year. In November a fresh sample of soil was obtained from the same house where the disease had been bad the previous winter. This was planted with young seedlings, and a number of them were quickly killed, the same fungus as before being found to be the cause of death. It is thus evident that once a soil becomes inoculated with this *Phytophthora* the infection may be carried on from year to year in the soil, though we do not yet know in what form the fungus lives in the soil and produces the infection of seedlings planted there.

The original source of infection by this fungus has not yet been found, though as seedlings grown close to diseased plants, but in clean soil, have never become infected it seems as though infection always takes place through the soil. Samples of maiden soil from rotted turf and of the manure used in the formation of borders in which disease has afterwards appeared have been used to try to produce disease in seedlings; but so far the results have been somewhat contradictory and no information on the original source of infection can yet be given.

The appearance of the disease can be prevented by sterilizing the soil in which tomatoes are to be grown, even if the soil has previously been infected. It has been suggested that in some cases the water-supply might be the source of infection, though it has never been proved that the disease actually has been introduced in this way. Sterilization of the soil would obviously be useless if infected water were used for watering. It is hoped that further investigations will reveal the way in which a soil originally becomes infected. Attempts are also being made to find some method of killing the fungus in the soil without injuring plants which are growing in it. If this can be done the treatment could be applied to the soil on the first appearance of the disease among the plants growing in it and the rest of the crop could be saved.

FURTHER EXPERIMENTS ON THE *RHIZOCTONIA* DISEASE OF ASPARAGUS.

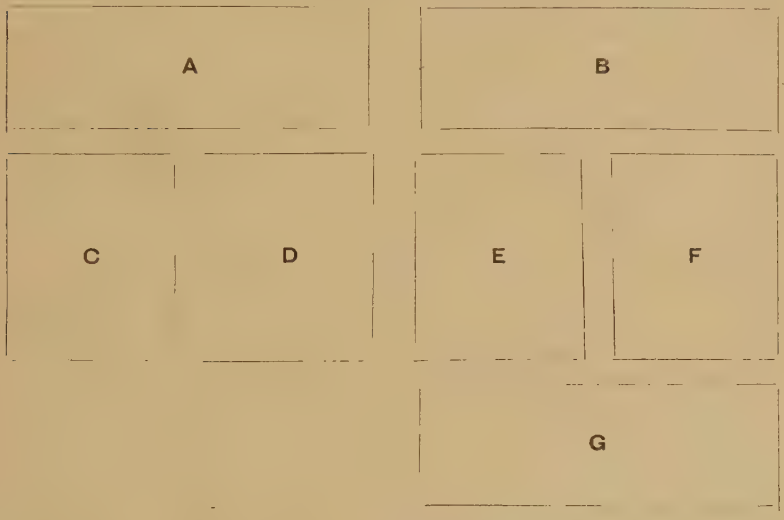
By B. T. P. Barker and C. T. Gimingham.

The Annual Report of the Station for 1916 contained an account of an outbreak of disease in an asparagus plantation at Badsey, near Evesham, caused by a soil fungus, *Rhizoctonia violacea*, var. *asparagi* (*R. medicaginis. De C.*), and of a series of experiments conducted on the infected land with the object of finding a substance capable of eradicating the pest. An infected portion of the land was divided into a series of seven plots, one of which received no special treatment, while the remainder were treated respectively with bleaching powder (2oz. per sq. yd.), carbolic acid (2oz. per sq. yd.), creosote (1oz. per sq. yd.), lime (30oz. per sq. yd.), naphthalene (2oz. per sq. yd.), and sulphate of iron ($\frac{3}{4}$oz. per sq. yd.). In the first five instances the fungicide was applied in early spring, a few weeks before the test crop was sown. The sulphate of iron was applied in two separate dressings at intervals during the summer, while the test crop was in active growth. The crop selected was carrot, this being more suitable for the immediate purpose than asparagus and equally susceptible to attack. The results showed that each of the fungicides tested checked the development of the disease, the untreated control plot showing very much more disease than the other six plots. The most striking effect was obtained with bleaching powder and creosote. The results with carbolic acid and naphthalene were not regarded as sufficiently promising for it to be worth while testing those substances further : but in the other four cases it was decided to proceed with similar trials in 1917.

The results from the latter trials are now available and not only confirm the 1916 work but afford ground for hope that an effective method of dealing with pathogenic soil fungi may at last be evolved. The general procedure adopted was the same as in 1916. The plots were treated with the respective fungicides towards the end of the second week in April except in the case of sulphate of iron, which was applied as before, and the carrot seed was sown at the beginning of May. The individual plots were dressed with the same substances as in the previous year, and the two plots treated with

carbolic acid and naphthalene that season were on this occasion given dressings of bleaching powder and creosote respectively at the strengths above mentioned. The control plot of 1916 served as the control plot for 1917.

Owing to pressure of other work little attention could be given to the plots until the lifting of the crop in November. Consequently the plants remained unthinned and the size of the individual roots was small. This, however, was a detail of little account so far as the actual trials were concerned, for the crops on all the plots were of uniform character except in respect of the



disease under investigation. The application of the fungicide in no case resulted in any obvious interference with the germination of the carrot seed ; and the subsequent growth of the crop showed that, whatever effect the fungicides in question might have upon growth conditions in the soil immediately after application, an interval of three weeks, as given in these experiments, between that time and the sowing of the seed is sufficient to allow any toxic effect to wear off.

The plan on this page shows the position of the individual plots.

The treatment of the plots was as follows :—

Plot A.	1916.	Lime.
,,	1917.	Lime.
Plot B.	1916.	Sulphate of Iron.
,,	1917.	Untreated.
Plot C.	1916.	Creosote.
,,	1917.	Creosote.

Plot D.	1916.	Carbolic acid.
„	1917.	Creosote.
Plot E.	1916.	Untreated.
„	1917.	Untreated.
Plot F.	1916.	Naphthalene.
„	1917.	Bleaching powder.
Plot G.	1916.	Bleaching powder.
„	1917.	Bleaching powder.

In order to give a fair comparative idea of the extent of the disease on the individual plots, as shown at the time of the lifting of the crop in November, 1917, an attempt was made to estimate it numerically. The control plot, E, was obviously the worst and the amount of disease thereon was accordingly expressed by the number 10. Plots A and B came next in order of disease, and the amount in these cases would be fairly expressed by 7 in comparison with the standard of 10 for the control plot. Plots C and D were marked 4 and 3 respectively, and Plot F 2. On Plot G there was merely a trace of disease and this was accordingly marked 1.

In view of the central position of the control plot, E, it is evident from the more or less marked reduction in the amount of disease on all the plots surrounding it that each of the fungicides tested has had some beneficial effect. At the same time the reduction in the amount of disease on the plots treated with lime and sulphate of iron (Plots A and B) has not been sufficient after two years' treatment to offer much encouragement of ultimate success under practical conditions. The results with creosote on Plots C and D were distinctly more encouraging, much more so in fact than the numerical estimate would indicate. What disease was present on these plots was almost entirely confined to two or three small areas, which suggests that the practical difficulty of ensuring uniform distribution of the fungicide over the whole area may have accounted for a few local areas being insufficiently treated. In addition, rain fell during the night after application of the material and this probably would serve to render the distribution of such a substance as creosote more irregular. The results with creosote in 1916 were so pronounced that these considerations should have some weight in estimating the 1917 returns: and for that reason it has been decided to include that substance in the more extended trials which it is hoped it will be possible to carry through in 1918. On the figure basis bleaching powder certainly appears to be the most efficient of the substances tested, its effect being strongly pronounced both in 1916 and 1917: and the proposed 1918 trials will be mainly concerned with more exhaustive tests of its action.

It is believed that the positive results obtained in these trials have

been due very largely to the time of application of the fungicides which were selected. Having in view the irregular results which had been obtained in previous work on the treatment of pathogenic soil fungi, it is considered that the question of time of application of the toxic substance is probably of primary importance in cases such as that of the *Rhizoctonia* here in question, in which the fungus seems definitely to winter in the soil in a resting condition. In that state it may be presumed that the organism during that period is in a form more or less highly resistant to the action of ordinary fungicides. *Rhizoctonia*, for example, exists in its sclerotial stage during the winter months and in this form must be undoubtedly more difficult to kill than in its actively growing mycelial form which develops when the soil temperature rises during spring and summer. The natural period for attack would, therefore, appear to be during spring and early summer before a new crop of sclerotia has had an opportunity of being produced. Hence the period selected for soil treatment in these experiments was during the spring, after the soil temperature had begun to rise. Owing to the necessity of allowing a sufficient margin of time to elapse for the injurious effect of the fungicide on plant growth to wear off, the actual time of application adopted, viz., mid-April, had perforce to be somewhat on the early side; and if it had been possible to defer application, a somewhat later date might have shown a still more decisive result.

This point is obviously of importance in connection with the general treatment of pathogenic soil fungi on these lines. It is clearly necessary to take into account both the life-history of the parasite, in order to decide the phase offering most promise of attack, and also the nature of the host-plant, in order to determine to what extent attack by direct fungicidal action is possible. In the present case, in view of the above results it appears that it would be comparatively easy to control the pest on an infected area of ground so long as a host-plant like the carrot was grown. Being an annual crop the sowing can be deferred until the land has been treated with a fungicide and time allowed for the toxic effect of the latter to lapse. With asparagus, the other type of host-plant involved in this instance, the problem is considerably complicated by the fact that the crop remains on the land for several years and its roots doubtless run the same risk of injury as the parasite itself during soil treatment with fungicides.

The next step in the present investigation, therefore, must be to determine how the fungicide can be applied with maximum injury to the parasite and minimum damage to the host. The method of solution of this problem will probably depend upon the extent to which the fungus has become distributed in an infected plantation. Soil fungi as a rule spread comparatively slowly. In the present case on the heavy clay land

at Badsey the *Rhizoctonia* does not advance much more than one yard a year. Consequently if infection is localised in a comparatively few centres in a plantation, these may be separately isolated and the parasite eradicated within the infected area. The sacrifice of the relatively few host-plants in those areas would be a comparatively small matter. On the other hand, if its distribution is general the sacrifice of the whole crop would be serious and some other line of action would have to be sought.

Acknowledgment must be made of the valued assistance which had been rendered by Mr. R. C. Gaut, the Agricultural Organiser for Worcestershire, Mr. Hall, the tenant of the land at Badsey, and Mr. A. H. Lees, of this Station. The whole of the work involved in the 1917 trials has been carried through by them, and without their help the experiments must have been discontinued until the conclusion of the war.

"REVERSION" OF BLACK CURRANTS.

By A. H. Lees.

In the Report for 1916 the connection between Big Bud and Reversion was discussed at some length for Long Ashton conditions. Further cases have since been investigated, especially some interesting material sent by Messrs. Seabrook & Sons, of Chelmsford. This material has thrown considerable light on some rather obscure cases. This variety is resistant to Big Bud, that is, under ordinary circumstances it does not develop the disease at all badly though it may show isolated big buds which do not, however, increase in number. The reasons for the resistance will be found in a separate article.

Here, as in the Long Ashton cases, the first cause of the disease was found in the interference by mite with the normal terminal growth. The check thus given to the terminal causes the lateral buds to make an abnormal growth the following year and consequently the bush becomes filled with lateral wood. Thus a similar result is obtained as in the mited Long Ashton material described in the Report for 1916.

Amongst the material from Messrs. Seabrook were some reverted shoots which showed extremely little or no sign of mite attack. Here a different cause was found. In nearly every case the terminal bud proved to be a flower bud. The flower bud in the black currant consists of a central rudimentary flower and two accessory lateral growing points. When, therefore, a flower bud is present at the terminal point of the shoot a check is given to terminal growth during the following spring until such a time as one or both of the accessory growing points take up true terminal growth again. The result is, as in mite-checked terminals, that abnormal growth is made from the lateral buds.

The terminal flower bud was found to occur only on shoots that were making a comparatively weak growth. Several causes may act to induce weak growth. Firstly the bush as a whole may be in a weak condition. Secondly, a wrong system of pruning may have been adopted. A sucker in its first year makes a strong growth and nearly always has a wood bud terminal. In its second year it is weaker, but usually has a wood bud terminal. In its

third and fourth year the growth is still weaker and the shoot has nearly always a flower bud terminal. If, therefore, suckers are allowed to grow for more than three years there is a great tendency for reverted wood to form, and consequently also for running-off of the fruit. In the best pruning methods no fourth year wood is allowed to remain and only a very little third year. Thirdly an aphis check in the summer may cause two or three terminal growths to be formed instead of one. These being weaker are nearly always capped by flower buds with a consequent tendency to reversion.

Fuller details of these cases are being published in the Annals of Applied Biology.

THE RASPBERRY AND LOGANBERRY BEETLE (*Byturus tomentosus*).

By A. H. Lees.

This raspberry pest is widely spread and it is a common experience to find fruit infested with the small grub that is its larva. Its presence considerably lowers the market value of the fruit and absolutely bars it from being used for canning. Since logan culture has increased the insect has shown a preference for this fruit so that where both kinds are grown together the raspberries remain comparatively free.

As soon as the weather becomes warm in the spring it appears from the soil underneath the plants where it has hibernated. If the raspberry or logan flowers are not yet open it attacks the young growing points of the plants and may also be found in apple flowers. When the logan and raspberry flowers begin to show it attacks these in great numbers. In bad cases three or four beetles may be found in a flower. They feed on the tissue at the base of the flower, the nectaries being probably especially attractive. As they feed they destroy the base of the stamens but otherwise do not do much direct damage. Very soon, however, the fertilised females begin to oviposit and the young larvæ burrow in the receptacle and later attack the fruit itself. The fruit may become entirely aborted or may be only one-sided in growth. The larva in the course of its feeding usually comes to the surface with the result that the skin is broken. Such spots are quickly attacked by moulds and this still further reduces the value of the fruit.

Remedies.—Lead arsenate has not met with much success since the beetle does not feed on the leaf and it is very difficult to get the poison into the flowers. The usual method adopted is to shake the flowers over pans filled with tree grease. The shaking has to be fairly violent as the beetles do not drop readily, especially on dull days, but by this method large numbers can be caught. It does not suffice, however, to keep the fruit free in bad cases. Ordinary contact washes fail to kill the beetle, in most cases at the best merely anæsthetising them. The beetle is indeed difficult to kill by contact washes.

An opportunity occurred in the spring of 1917 to test the effect of a spray mixture which had already given good results against the beetle on a small scale. This mixture has the following formula :—

Soft soap	20lbs.
Paraffin	2 gallons
Nicotine	½lb.
Water	100 gallons

The soap is dissolved in 5 to 10 gallons of boiling water and the paraffin thoroughly emulsified into it by means of a syringe. The nicotine is then added and the mixture finally made up to 100 gallons. As explained in previous reports this 2 per cent. paraffin emulsion has great wetting and penetrative powers and serves as a carrier to the nicotine. By its means the poison is brought as intimately as possible into contact with the insect.

The plantation on which the experiment was made was very badly attacked and the experiment was made on a scale large enough to give results on a commercial scale.

In practice it was found necessary to give a preliminary spraying in order to force the insects from their hiding places. For the purpose the 2 per cent. paraffin emulsion without nicotine was employed. Unless this were done the nicotine spray failed in its action simply because very few of the beetles were thoroughly wetted.

The method employed was to send one knapsack sprayer containing paraffin-emulsion on in advance and to follow up five minutes later with a second containing nicotine-paraffin-emulsion. By this time the beetles had come out of their hiding places and a good kill was secured. This double spraying was done three times during three weeks and then stopped.

At the ripening time a count was made and it was found that whereas in control rows 100 per cent. were infected in sprayed rows only 33 per cent. were. Since the sprayed portion was only a small part of the whole, re-infection from uncontrolled parts probably occurred. In addition only three double sprayings were done though at the end there were still fresh beetles appearing. These two factors probably caused the result to be worse than it otherwise would have been.

FURTHER EXPERIMENTS ON BIG BUD MITE.

By A. H. Lees.

Since the mixture of 10 per cent. soap and 5 per cent. crude carbolic acid had been shown to be effective in killing big buds in the winter condition further experiments were made in its use in the winter of 1916–17. One spraying was usually sufficient to penetrate and kill big buds situated low down on the shoot but was much less effective on terminal big buds and those situated high up. The reason for this is, of course, that the low big buds, being first formed, are relatively older and, therefore, more loose in structure. Consequently the spray fluid penetrates more easily. There was also some doubt at to what was the best time during the winter season to spray.

Accordingly the two varieties, Boskoop Giant and Ogden's Black, were sprayed at three different times, namely (*a*) at the beginning of December, (*b*) at the beginning of January, and (*c*) at the end of February. In addition some bushes were sprayed at (*a*) and (*b*) and (*a*) and (*c*).

In the spring the number of killed and living big buds were counted on each experimental plot, giving the following results :—

Treatment	Ogden's Black Big Buds		Boskoop Giant Big Buds	
	% killed	% living	% killed	% living
(*a*) ..	60	40 (2·0)	63	37 (2·75)
(*b*) ..	65	35 (2·83)	52	48 (2·5)
(*c*) ..	71	29	58	42
(*a*) + (*b*) ..	86	14 (1·33)	65	35 (2·33)
(*a*) + (*c*) ..	83	17 (1·66)	79	21 (1·83)

Looking at the results from the Ogden's it is evident that none of the times selected gave appreciably better results than the others when one spraying only was given. The figure for (*c*) included too few bushes to be reliable. Two sprayings, at whichever time done, at once reduced the percentage of living big buds. The results with the Boskoops were not nearly so good and, indeed, it

has long been noticed that the big buds on this variety are particularly difficult to penetrate.

Other bushes including "French," Lee's Prolific, Black Naples, Victoria and Baldwin were also given two sprayings at times (*a*) and (*c*), and (*b*) and (*c*). Counts of killed big buds were not made in this case as the distribution of big buds was very irregular.

This experiment included six rows of bushes. Three others were left as a control and three more sprayed with lime-sulphur at winter strength at the beginning of April.

In the Big Bud experiments carried on at Long Ashton for a series of years it has been the custom every winter to give each bush under observation marks indicating roughly the degree of attack. Thus 0 means none visible, 1 is slight, 2 is moderate, and 3 bad. The figures for the previous year therefore give a much better control for any particular bush than any obtained from bushes outside the experiment since in any collection of bushes the distribution of big bud is often most irregular.

In the foregoing Table the figures in brackets indicate the average degree of attack for the bushes (about six in number) under the different spraying treatments. The previous year they were all over 2·5, being badly attacked.

In the Ogden's Black the figures for the winter of 1917–18 follow fairly closely those for living big buds obtained in March, 1917. The double spraying has in both cases given markedly better results. It is somewhat remarkable, however, that when the percentage of living big buds has been brought down to 14 so much infestation occurs in the following year. It is obviously necessary to bring the percentage down nearly to zero before a satisfactory result could be obtained. The Boskoops give rather irregular figures though one of the double sprayings is decidedly the best.

The results given in the following Table show that the early and late sprayings gave the better result. There was no decided result from lime-sulphur.

TABLE.

	Victoria		Baldwyn	
	1916	1917	1916	1917
1st 3 rows (*a*) and (*c*)	1·4	1·1	·8	·9
2nd 3 rows (*b*) and (*c*)	1·47	1·9	·66	1·1
3rd 3 rows lime-sulphured	1·64	2·0	1·5	2·2
4th 3 rows (Control)	1·3	2·6	·85	1·25

On the whole the indications are that the early spraying is important when a double spraying is done and that probably three sprayings would give a better result than two.

COPPER STEARATE.

By A. H. Lees.

Burgundy and Bordeaux mixtures have been now for many years recognised as reliable fungicides. Their action is protective and protective only. They have no contact fungicidal powers nor do they spread easily when sprayed on to a leaf or fungus mycelium.

Trials were made at Long Ashton two or three years ago in order to find some means of remedying these deficiencies.

Since 2 per cent. paraffin emulsion (2 per cent. soap, 2 per cent. paraffin) was known to give the highest wetting and spreading power, an attempt was made to combine soap with Burgundy mixture. Bordeaux mixture was obviously unsuitable owing to the excess of lime which immediately precipitated the added soap. When added to Burgundy mixture made in the ordinary way interaction took place between the copper compound and soap resulting in a curdy precipitate. The soap was thus rendered inactive.

To overcome this difficulty the addition of ammonia to copper sulphate before adding the requisite amounts of sodium carbonate and soap was tried. This resulted in a stable mixture but required rather a large amount of ammonia. When sprayed the ammonia gradually evaporated, leaving the copper sulphate to react with the soap. The surface was thus finally covered with a copper soap which for the sake of simplicity may be called copper stearate.

It was found that far less ammonia need be used if a certain amount of caustic soda were added at the same time as the carbonate and soap. The resulting mixture, however, was found to cause defoliation, when used either alone or with emulsified paraffin, on gooseberries. In addition, it did not appear to have very satisfactory protective properties. The mixture was therefore given up as useless. At the same time the possibility of a simple mixture of copper sulphate and soap was ruled out by the fact that when soap was added to copper sulphate an exceedingly sticky and unmanageable compound was obtained.

It was not until a considerable time later that it was found that if the mixing took place in the reverse way, that is by adding copper sulphate solution to soap solution, an entirely different result could

be obtained as long as the soap was in excess and the solutions sufficiently dilute. Thus when 20cc. of 1 per cent. copper sulphate is carefully added to 100cc. 1 per cent. soap solution with constant stirring the mixture assumes a characteristic opaque light blue colour. This proved to be due to an exceedingly fine precipitate of a copper soap compound. When a thin film is dried on a slide and examined under a ⅙ objective it was found to consist of an enormous number of exceedingly fine, barely visible particles. Their exceeding fineness results in the mixture being non-filterable and to the precipitate remaining suspended for days with only very slight settling. It also accounts for the opacity of the mixture. In fact the particles appear to be in a state of emulsion in the soap solution.

If much more than 20cc. of 1 per cent. copper sulphate is added to 100cc. of 1 per cent. soap solution the physical nature of the mixture is changed, all the fine copper soap particles running together to form a thick sticky mass. In this respect it behaves like an oil emulsion in soap which de-emulsifies as soon as the emulsifier is destroyed in any way.

The copper soap formed was found to be a mixture of the salts of stearic, palmitic and oleic acids. Since stearic acid is usually present in preponderance the compound may be called for the sake of convenience, copper stearate. Of course, for any particular soap used the resulting copper compound will depend on the fatty acids originally present. In view of the frequently changing composition of soft soaps due to war conditions it is impossible to lay down any hard and fast rule for its composition.

Dilute acid causes the blue of the mixture to change to white, doubtless due to the formation of the fatty acid from the copper soap. The resulting soluble copper salt is too dilute to affect the colour. Alkalies also cause a paling of the blue into a less dense and lighter blue. This change is probably associated with the formation of copper hydroxide and reformation of the original soap. The speed with which these two reactions take place is evidence of the fineness of the precipitate and reminds one of the behaviour of a solution rather than a precipitate.

As the mixture contains soap in excess it is possible to increase the wetting powers very greatly by combining it with a 2 per cent. paraffin emulsion. The combined mixture remains homogeneous except for the fact that the paraffin soap emulsion tends, as in the simple paraffin soap emulsion, to rise to the surface. The combined mixture will wet resistant surfaces like the summer stage of American Gooseberry Mildew with ease. Without paraffin emulsion the copper stearate mixture has a good spreading power on ordinary foliage and when dry leaves an almost imperceptible film of exceedingly fine and close particles.

The size of these particles averages 2–3 μ though a few considerably coarser particles are generally present. The space between any two particles varies from about 2–5 μ. It would, therefore, be impossible for a germinating fungus spore to penetrate a sprayed leaf without coming into contact with several particles. For practical fungicidal purposes therefore the coat may be regarded as continuous. Such a sprayed surface has one further advantage. It resists wetting completely, water running off it in drops instead of spreading. This may be due to very slight decomposition of the copper stearate into stearic acid, or it may be a property of the stearate itself.

The strength of the copper in the mixture is ·16 per cent., that is about $\frac{1}{6}$th of that in the formula recommended for Burgundy mixture by the Food Production Department. If the mixture is brought up to 1 per cent. of copper sulphate the physical properties are partially destroyed as a certain amount of the copper stearate runs together into curdy masses. It may, however, be brought to a percentage of 1·6 by dissolving a small quantity of gelatine in the stronger copper sulphate before addition of the correspondingly stronger soap solution.

It is not yet known whether the mixture possesses fungicidal properties. The fact, however, that it is easily decomposed by dilute acids renders it quite likely. It would appear probable that the protoplasm of a germinating spore would render a certain amount of copper soluble just as it does in the case of Burgundy mixture.

In order to get some light on its possible fungicidal properties methods similar to those employed at this station by Barker and Gimingham in their work on Bordeaux Mixture were adopted. For example, bean seedlings were grown in the mixture. As a control others were grown in a $\frac{1}{2}$ per cent. soap solution. This was done to see if the small amount of alkali had any effect. Since the mixture is nonfilterable the effect of the precipitate by itself could not be tried as may be easily done for Bordeaux and Burgundy mixtures. The beans grown in copper stearate emulsions showed blackened areas on the root above the liquid, but the portion in the liquid appeared normal. Those grown in $\frac{1}{2}$ per cent. soap solution had their roots completely blackened. Similar results were obtained for mustard grown on flannel soaked with the emulsion and dipping into it, and for mustard grown on flannel dipping into $\frac{1}{2}$ per cent. soap solution. The results, therefore, gave no indication whether the copper stearate was injurious to root hairs. In order to avoid this difficulty a different method was adopted. Sufficient sand to fill a 4-inch pot was wetted with copper stearate emulsion and dried gradually. It was then placed in the pot and thoroughly well washed with water till no soap or alkali could be detected. Bean

seedlings grown in this sand showed blackening of the roots comparable with that obtained with beans grown in a Bordeaux precipitate. To test mustard, flannel was soaked in the stearate emulsion, dried and thoroughly washed with water. Seed sown on this surface and kept moist showed a very small per cent. of germination compared with a control on flannel moistened with water. Those that did germinate showed blackening of the root tips.

These experiments appear to show that copper stearate is sufficiently dissolved by root hairs to cause copper poisoning. It is likely, therefore, that it will prove fungicidal.

INVESTIGATIONS ON APPLE STOCKS.

By B. T. P. Barker and G. T. Spinks.

The work on this subject, which has been in progress since 1913, has been previously referred to in the Annual Reports since that date, and some idea of the objects of the investigation, the nature of the problems and the directions in which the results were tending has been given. During the course of the past year a point has been reached which may be considered as marking the completion of the first stage of the investigation. The large numbers of stocks originally collected for examination at the start of the work have been under close observation during the intervening years, and it has now been possible not only to arrive at definite conclusions as regards the different types or classes of stocks which occur, but also to select standard examples of each type for propagation and future study. During the next few years the propagation of the selected individuals will constitute the chief item in the programme of work and probably little of material interest to report upon will arise in that direction. The final stage of the investigation and its ultimate aim will be reached when these individuals are propagated in numbers sufficient to permit of comparative trials of their respective merits as root-stocks at a number of centres throughout the country.

The present, therefore, seems to be a satisfactory time to review in some detail the results of the work up to the completion of the first stage. The following account does not purport to be more than a summary of results, since it is intended to publish a full illustrated report shortly.

The investigation was started because it was recognised that the whole basis of research on the culture of apple trees ran the risk of being unsound, until the possible effect of root-stock influence was elucidated. Every tree except seedlings is worked either on the Paradise, free, or so-called crab stock; various strains of Paradise stocks are being used by different nurserymen; and every free and crab stock utilised represents a distinct individual, no two being absolutely identical. Granting the possibility of root-stock influence, it is evident that the results of every cultural experiment with apples

can be vitiated by differences in the root system of the individual trees concerned, unless due precautions are taken to ensure the use of the same root-stock throughout. The latter can be arranged readily enough in the case of Paradise stocks by using only root-stocks from the same original stool ; but hitherto all work with trees on crab and free stocks must be regarded as open to suspicion because all such trees have been worked on different individual seedlings. To overcome the latter difficulty, when the first nursery was established at the Institute in 1904 a selection of ten free stocks of fairly distinct types was made and these have been propagated as freely as possible since. Trees worked on these stocks of known history are being used for experimental work in the Institute plantations at the present time.

When increased facilities for research in fruit culture became possible in 1912 by the allocation or specific grants for the purpose from the Development Fund, resulting in the extension of the work at Long Ashton and the establishment of a new experimental centre in connection with the South-Eastern Agricultural College at East Malling in Kent, it was decided to undertake an exhaustive investigation on root-stock influence at the two places named. It was arranged that the examination of the various strains of Paradise stocks should be conducted at East Malling, while similar work on free and crab stocks was to be taken in hand at Long Ashton. The present article is only directly concerned with the latter work, a very complete account of the results of the Paradise stock investigation having recently been published by Mr. R. G. Hatton in the Journal of the Royal Horticultural Society.

The primary objects of the investigation, stated in order of sequence, were :—

(*a*) to obtain detailed information as to the characters of the various root-stocks used in apple culture,

(*b*) to examine the nature and extent of the influence of the respective types of root-stock, and

(*c*) to select, with the view of their ultimate adoption as standard types in the fruit-growing industry, the forms which offer most promise for the various kinds of trees (standard, bush, cordon, etc.), for the varieties of apple worth serious consideration as commercial sorts, and for the different types of soil and situation adapted for apple culture.

The importance of the investigation lies not merely in its bearing upon the problems of apple culture ; it may be expected to throw light on some of the general questions common to all plants which are propagated by budding or grafting. That there is such a thing as root-

stock influence cannot be doubted by those who have had practical experience with various forms of stocks ; but, although in the cases of a few plants a certain amount of information has been acquired, generally speaking, the existing knowledge of the subject as a whole is exceedingly limited. Mr. Hatton in his paper referred to has shown how lacking in precision was the knowledge of the various Paradise stocks prior to their study at East Malling. To a much greater degree a corresponding statement may be made as regards the free and crab stocks.

Without attempting to consider the matter in detail it is perhaps desirable to specify briefly some of the ways in which root-stock action may be involved.

Firstly, since the root-system of a plant is that part of its organisation which is concerned with the absorption of all food material other than carbon dioxide, it is evident that questions of nutrition, the nature and quantity of the various elements of food supplies, and, incidentally, the water supply, are concerned. Thus not only the general health of the tree but also such other points as vigor of growth, fruitfulness, and quality of fruit may be affected : probably, too, longevity. There is reason to believe also that the degree of susceptibility to certain fungoid diseases, *e.g.*, canker caused by *Nectria ditissima*, is to some extent dependent upon the nature of the root-stock.

Another important direction in which the root-stock is directly concerned is that of the physical character of the soil in relation to the plant. It will be shown in due course that in the case of apple stocks there occur all types of root-systems between the coarse, tap-rooted, sparsely branched type, practically devoid of all fibrous rootlets, and the type which consists of a mass of fine fibrous roots with an almost complete absence of strong roots. It stands to reason that a soil of a given physical character may be admirably suited for one type and quite unsuited for another. Heavy soils, for example, are generally regarded as adapted for the growth of plants with strong coarse roots and light soils for those with abundant fibrous roots.

Still another point of possible importance, and one in which there appears to be little known definitely at present, is the season of active growth of the stock. It has been observed that some stocks start into growth decidedly earlier in the spring than others, and similarly there are differences in the time of cessation of growth in the autumn. How far such differences affect the variety worked upon them remains to be seen.

From this short review it is evident that the question of root-stock influence is one which may have a very considerable bearing upon the behaviour of the tree and which must be taken seriously into account in any work on apple culture.

Kinds of Stocks.—At present the kinds of root-stocks used for apples are generally grouped into three classes, viz., Paradise, free and crab-stocks. It is not proposed here to enter into any discussion as to the origin or relationships of these classes. Expressed broadly the main distinctions between them are usually regarded as follows :—

Paradise stocks are more or less markedly fibrous in character, mainly surface-rooting with a few coarse deeply growing tap roots, and reputed to exert a dwarfing effect on the growth of the tree and to induce early fruiting. (Mr. Hatton's article shows how erroneous some of these ideas are in the case of certain of the so-called Paradise stocks.) They are readily propagated by layering, and are used under ordinary circumstances only for bush, pyramid, or cordon trees.

Free stocks are simply seedlings obtained from the seeds of any cultivated kinds of apples. In practice they are raised almost exclusively from seed of cider apples. Propagation by layering is not considered worth attention and is not practised in their case in commercial work, since in the average case, unlike Paradise stocks, they do not root readily. The root system is generally of a coarser, less fibrous type, encouraging growth but delaying fruiting : and for that reason they are used mainly for the stronger types of trees, such as standards and half-standards.

Crab stocks also are seedling and not layered stocks, the reputed distinction between them and free stocks being that they are raised from seeds of wild-growing crab apples. In general the root-system is supposed to be similar to that of the free stock, but the crab-stock has always been credited with imparting greater hardiness to the tree.

In the following account of the investigations at Long Ashton no attempt has been made to treat the crab and free types separately or to differentiate in any way between them. The work up to the present having been concerned exclusively with the morphology of the root-system, there has so far been no need for separate treatment. There are no essential differences in the root forms of these two classes, and it remains for the future to show if there are actually the reputed differences in hardiness.

Although the Paradise group of stocks does not come under detailed consideration here, it must not be inferred that this indicates that they are regarded as a distinct and unrelated class. On the contrary, it is desired in this article to emphasize the view that there is at the present time no material distinction from the botanical side which can be drawn between the three specified groups of stocks. In all probability the present-day forms would show, if it were possible to trace back their history, the same original group of common ancestors : and it is believed that the correct way

of regarding them is simply as a series of hybrid varieties produced by much natural inter-crossing between, in the first place, the botanical species from which the ordinary cultivated apple has arisen and later, the varieties resulting from the earlier natural hybridisation. In a word, it is thought that they have a more or less common history and that the system of grouping generally adopted is based rather on chance morphological resemblances than on natural relationships. If this view is right, it follows that every Paradise form and every free and crab-stock, while definitely related, yet represents a distinct individual seedling with a separate parentage of its own and a combination of characters determined by the nature of that parentage. The problem of stock influence then, reduced to essentials, becomes this. Is the action exerted merely mechanical in nature and regulated by the morphology of the root-system, or is there definite physiological influence, the nature of which is determined by the character of the seedling ? So far as the present investigation has proceeded, it is rather on the morphological side that attention has been concentrated; but as the work develops in the later stages it should be possible to see to what extent the other side must be taken into consideration. It need hardly be pointed out that if physiology as well as morphology comes into play the whole position is enormously complicated. On the other hand, the possibilities of striking developments in the culture of the fruit are equally increased.

Free and Crab-Stock Types.—The large collection of free and crab-stocks at Long Ashton which had been examined and classified in 1914 and 1915 was again examined in March, 1917. Several hundred stocks which were originally obtained as "one year transplanted stocks" were carefully classified according to the character of their root-systems, and it was found that eight or nine fairly definite types could be distinguished. In many cases, of course, there was some doubt as to which of two types a stock resembled; but as the classification was necessarily only approximate, no classification according to actual measurements being feasible, slight variations from type are of no importance.

The whole of these stocks, therefore, were placed in one or other of the nine classes which it was decided were fairly definitely recognizable.

When all the "transplanted stocks" had been classified a few of the most typical and promising of each class were selected for propagation and the remainder were discarded. The collection of free and crab stocks from various nurserymen which had been grown for the last four years, and which had received similar treatment in the way of lifting, examination, re-planting and earthing up, was then examined. The same course was taken with

stocks obtained as seedling free stocks and with stocks raised from seed of the Paradise apple. In all these cases no complete classification was attempted, but the roots were examined to see if any fresh type could be found. However, no fresh type of root-system was found, though a number of very good examples of the typical classes were found and these were added to the selection of types. In all, about 60 plants have been selected from the whole number of stocks examined and these have been planted out and will be available for future investigations.

A general description of the characters of each type of root-system is given below, the only point noted about the stem being the degree of vigour of growth :—

Class A.—A mass of fine fibrous roots, practically no coarse roots. Stem usually distinctly dwarfed.

Class B.—Similar to A but with a few coarser roots. Stem slightly more vigorous.

Class C.—Numerous moderately strong horizontal lateral roots bearing much fibre. Fairly strong growth of stem.

Class D.—Very numerous weak or moderate laterals which have a distinct downward habit of growth. Less fibre than C. Stems variable but usually fairly strong.

Class E.—Similar to D, but laterals somewhat less numerous. Strength of stem about equal to B.

Class F.—Numerous strong horizontal laterals with fair amount of fibre. Strong growth of stem.

Class G.—Horizontal laterals stronger but not so numerous as in F ; less fibrous than F. Original tap and lateral roots fairly active. Strong stems.

Class H.—Original root-system persistent, little adventitious rooting.

(*a*) Stem strong.
(*b*) Stem dwarfed.

Class J.—Similar to H, but adventitious roots almost absent.

(*a*) Stem strong.
(*b*) Stem dwarfed.
(*c*) Suckers on roots.

It must be noted that all these stocks had been cut down in 1915 and earthed up for two years to form stools for the purpose of propagation, and that all the roots referred to above are adventitious roots springing from the base of the old stem except where they are definitely described as " original " roots.

In classes A to F the original roots had apparently entirely ceased

to grow and to have any effect on the growth of the stock, the plant depending entirely on the adventitious roots above.

It has yet to be seen whether the root-system of a stock which had grown for the same number of years without being earthed-up would be similar to that of an earthed-up stock of the same kind.

From the above description of the nine classes of root-system recognised it will be seen that there are two extreme types with transitional types between them. In stocks of Class A there are no coarse tap or lateral roots, but the whole root-system consists of fine fibres, while the stem is usually dwarfed. In Class B coarser roots appear among the fibres and the stem is slightly stronger. Then the stocks in Classes C to G show successively fewer fibres and an increased tendency for the roots to consist of strong laterals, until in Class G there are found practically no fibrous roots but a small number of very strong laterals. Stocks of Class H are still strong in growth, but seem to depend mainly on their original roots, there being few adventitious roots and very little fibre anywhere. Class J contains stocks which are dwarfed and which bear no fibrous roots and no adventitious roots.

It is thus seen that there are dwarfed plants at both ends of the series, those in Classes A and B being due, apparently, to the almost entirely fibrous character of the roots, and those in Class J to the absence of any except a few poor tap-roots.

The non-formation of adventitious roots distinguishes Classes H and J from the rest, but it is possible if stocks were grown in the normal way, without earthing up, that the roots formed would resemble the non-adventitious roots of stocks of other classes grown under similar conditions.

For practical purposes the stocks may possibly be divided into only three types, assuming that Classes H and J would produce only non-fibrous tap-roots under all conditions. In Type 1 would occur Classes A and B, where the root-system is almost entirely fibrous and the plant is dwarfed in growth. Type 2 would contain all the intermediate classes from C to G, the roots being mainly laterals of greater or less strength with a varying amount of fibre. It is possible that this type would have to be sub-divided, as Classes D and E have laterals with a downward tendency, while Classes C, F and G have horizontal laterals.

The third type would consist of Classes H and J, the non-fibrous tap-rooted stocks without laterals, the stem growth being either strong or weak.

It is certain that these three main types can be readily distinguished, while it is rather doubtful whether the smaller divisions always represent real differences. Thus, stocks in Classes D and E have very similar root-systems and it is possible that the roots of

one such stock might vary between the D and E type according to the soil in which it was grown. Similarly Classes C, F and G all have roots of the same general type, the only differences between them being the slightly varying strength and number of laterals and the amount of fibre. It is conceivable that the roots of a stock might conform to any of the Classes C, F or G according to the conditions under which it was grown ; but it is extremely unlikely that any change in the conditions of growth could induce such a stock to form a root-system of the A, B, H or J type.

It is also possible that stocks of Class J are really Class H plants which have only made weak growth owing to slightly different soil, moisture, or other conditions of growth. For the present, therefore, the free stocks may be divided into these three main types :— (1) fibrous rooted, (2) with lateral roots and some fibre, (3) with coarse tap-roots.

No record was made of the exact number of stocks placed in each class, but an approximate figure can be given for the proportion of stocks in each main type. About 1,200 stocks were retained for the final examination, and of these only about 2 per cent. were found to belong to the very fibrous-rooted Type 1. The intermediate Type 2 was by far the most numerous and made up about 90 per cent. of the whole number, while the remaining 8 per cent. belonged to Type 3. Considering the numbers of stocks dealt with and the widely different sources from which they came, it is probable that these percentages represent more or less the proportions of the different root types which would be found in any chance collection of free stocks.

It is evident that any collection of free stocks will probably include plants of widely differing root habit and that the effect on trees worked on these stocks may be correspondingly different. Up to the present time it has usually been assumed that all " free " stocks will produce the same kind of trees when worked with the same variety, but this assumption is not likely to be correct, since the root-systems of the free stocks differ so widely ; and this doubtless accounts for the actual difference which does often exist between individuals of the same variety worked on free stocks and grown under the same conditions. To secure uniformity in results when free stocks are used it seems therefore necessary to use stocks which conform to certain standards in their root-systems. This could be done if pure strains of stocks could be propagated by vegetative methods in the same way as Paradise stocks are propagated ; and this subject will be referred to again later in this article. If, however, free stocks are to be raised from seed, as they now are, it must be considered whether it is possible to obtain with certainty a collection of stocks with roots of the same general type. In other words, can the nurseryman when raising his

seedling stocks for transplanting classify them according to the type of root-system which they will develop when older? Does the root-system of a seedling give sufficient indication of the type of roots which will develop later, or will the type of root change as the stock grows older? This question can be answered to some extent by referring to the records of some of our stock examinations. All the stocks, as seedlings or "1 year transplanted stocks," were classified before planting early in 1914. In 1915 they were lifted and examined in detail again and this was repeated in 1917. A comparison of the notes made in each year concerning the various individuals shows how far the original classification holds good after another three years' growth. On the whole the stocks still show the same root characters which they had in 1914, though it cannot be said that young stocks can be classified with absolute certainty. Thus some individuals which in 1914 were classed as fibrous-rooting have since developed much coarser roots, while others then recorded as being lacking in fibre have now formed good fibrous root-systems. Perhaps some of these discrepancies are due to the difficulty of distinguishing between "fibres" and "weak laterals" when dealing with very young plants. Still, it seems possible to separate Type 1 from Type 2 with very fair accuracy when examining seedlings or 1 year stocks. The agreement between the classifications of 1915 and 1917 is even closer. But the distinction between Types 2 and 3 in the early stages was very often found to be wrong in 1917.

The most common type of free stock is Type 2, in which there is a strong-growing stem with numbers of moderately strong lateral roots which grow fairly near the surface of the ground. As this is the type of stock desired when a "free" stock is asked for, it is probable that considerable attention will be given to the production of stocks which can be relied on to be true to this type. But the stocks of Type 1 are also extremely interesting and deserve description in more detail.

The roots of these plants consist of a mass of fibres, which in some cases are mixed with a few rather coarser lateral roots, while in other cases there are no coarser roots. The fibrous roots grow with remarkable freedom on the original root, and as adventitious roots from parts of the stem. The young stocks after examination early in 1915 were cut back and re-planted, and after fresh shoots had grown they were earthed up so as to cover the base of the young shoots: this earthing-up was continued until the next examination in 1917. In September, 1915, a number of these stocks which had shown signs of free rooting, were examined by scraping away soil from one side of the heap, the soil being moulded up again after the examination. In almost every case young roots were found on the stems, most frequently on the older part of the stem which had been

cut down, but also often on the base of the new shoots of the current year. In 1917 the whole of the oldest part of the stem which had been covered with soil was often found to be a mass of fibrous roots, the original roots which had been deeply buried having ceased to be active. At this time, too, some of the new shoots and almost all those of the previous year were well rooted where they had been covered with soil. The stems of many of the stocks of Type 1 show swellings or knots from which roots readily spring if the stems are earthed up, and sometimes very short root-tips appear even on stems exposed to the air. These swellings, root-knots or burrs are precisely similar to those described and illustrated in Mr. Hatton's article on the Paradise stocks in the Journal of the Royal Horticultural Society for September, 1917.

The shoots of these stocks of Type 1 are usually distinctly less vigorous in growth than those of Type 2, and are sometimes much dwarfed, though apparently quite healthy ; but recent examination of the stocks which have made a further year's growth in 1917 shows that some of them have made fairly strong growth this last year. The more or less dwarfed habit, the fibrous surface roots and the great ease with which stems root are all characters which have hitherto been considered typical of the Paradise stocks.

All the Paradise stocks now in use must originally have arisen as chance seedlings, and there is no reason why fresh stocks of the Paradise type equal, or possibly superior, to those now in use should not be found. It is quite possible that some " free " stocks of this Type 1 may be found to be more suitable for use as Paradise stocks than the existing Paradise types. In order to test this all the best individuals of the fibrous type which have been found are now being kept for propagation so that their practical utility as stocks may be tried in the usual way.

Comparing photographs of some of these Type 1 free stocks with the illustrations of the Paradise stocks in Mr. Hatton's paper it certainly seems as though some of the free stocks are more free and fibrous in their rooting habits than many of the Paradise stocks.

No attempt has been made to classify or describe the stems and foliage of these stocks. As they are all raised from seed there are no two alike, being hybrids, and it would be quite useless to spend time in cataloguing their individual shoot characters. If any of them are found to be worth propagating vegetatively as definite varieties of stocks, then, of course, it will be necessary to make detailed descriptions of them in order that they may be identified in the future.

For the present it has been thought sufficient to note roughly the different stem and leaf types which occur. It has not been found that there is any correlation between different stem and root types :

any type of stem may appear or any type of root. One important point to be noticed in choosing a stock for working purposes would be the " clean-ness " of the stem, that is, whether a young stem is unbranched or whether it is " feathered " with branches or spines. A clean stem is much more convenient for working on than a feathered one. Seedlings with stems which are more or less branched are the most common among the stocks examined and they may be either stout or whippy. The branches themselves also vary in length and in strength and in the number of spines they bear. The seedlings with clean growing stems are not so numerous, but there is a fair proportion of them. The chief differences between the various clean stems consist in the stoutness or whippiness and the length of the internodes.

Propagation—If pure strains are wanted of any free stocks, whether of the 1st, 2nd, or 3rd types, it is obvious that the stocks must be propagated vegetatively, and the question of the best method of doing this now arises. Propagation by stem cuttings has been tried at Long Ashton with a number of the stocks, but so far without any adequate degree of success. The possibility of propagation by this method must not be entirely ruled out, however. Numbers of root cuttings were also made in 1915 and from these a fair proportion of plants have been raised. With more experience of the most favourable conditions for the growth of root cuttings it is possible that this method might be of considerable use. Propagation by stool-layering seems, however, likely to be of more immediate service. All the free stocks here have been cut down and earthed up with the intention of forming stools, as already described in the 1915 Report. In the case of stocks of Type 1, as mentioned above, shoots of the previous year, and sometimes of the current year, have rooted freely, and a number of new plants have been obtained by cutting off these rooted stems. There is no doubt that stocks of this type could readily be propagated by this method or any other method of layering. Stocks of Type 2 have also yielded numbers of new plants by this method, and it is probable that this method of propagation could be used successfully with nearly all stocks of this type. But usually it is only the one year old shoots and not the new shoots of the current season's growth which root in these cases.

The readiness with which stocks of both Type 1 and Type 2 form adventitious roots is most noticeable. Many Type 2 plants have formed very strong roots from the earthed-up portion of the main stem, so that the original roots have become functionless, while at the same time very strong shoots have formed. It is thus evident that sufficiently strong adventitious roots could be obtained on layers to enable the layer to grow strongly when detached from the parent plant. And, in fact, many layers separated from the stools

in April, 1917, made good growth during the summer and now seem well established.

Stocks of the third type cannot be propagated by layering, or, only rarely, owing to the absence of the ability to form adventitious roots.

Constancy of Root Characters.—At the present stage of the investigations it is impossible to say how far the roots of an individual when grown under different conditions may vary from the type with which it is now classified.

As mentioned above, all the classifications have been made with stocks which have been transplanted several times and which have been earthed up for two years. These operations may have caused some modification of the natural rooting habits of the plants and it will be necessary to grow the selected stocks under the same conditions as they would be under if used commercially for stocks. Young rooted layers will have to be planted and allowed to grow for, say, four years without any cutting back, earthing-up or lifting for examination. At the end of that time the plants will be lifted to see if the roots formed under these undisturbed conditions conform to the type with which they were originally classified. If that is found to be the case stocks of desirable types can be propagated for practical use and their effect on grafts noted.

There is still the question to be considered as to how far stocks propagated vegetatively may vary from the type of the parent plant, but there is good reason to suppose that no variation of consequence occurs under normal conditions.

THE MANUFACTURE OF CIDER APPLE JELLY.

By B. T. P. Barker.

In view of the fact that it was evident that there would be need for as large supplies of jam and analogous products as could be produced until the 1918 fruit crop became available, it was decided by the Food Production Department of the Board of Agriculture to attempt to utilize a portion of the abnormally great cider fruit crop of 1917.

Cider apples and perry pears represent the only considerable supplies of fruit not normally used in some form for food purposes, being converted exclusively into cider and perry except in seasons of scarcity, when certain kinds of such apples and pears are drawn upon for jam-making and, to a less degree, for dessert and culinary use. The total acreage of grass orchards of apples and pears in the West of England is about 100,000 acres. These orchards are comprised mainly of cider and perry fruit. A big and hitherto largely untouched source of material of potential food value is thus available, provided that suitable methods of dealing with the crop are adopted.

No attempt was made in 1917 to utilise perry pears. Attention was concentrated on cider fruit.

Cider apples may, as already frequently indicated in these Reports, be divided into three main groups: (*a*) sours, (*b*) sweets, (*c*) bittersweets. The sours are distinguished from the other two classes by their relatively high content of malic acid, the amount in the average case well exceeding ·45 per cent. of acid in the juice. The acidity of sweet and bittersweet apples is normally much below that figure. The only difference of importance between the two latter classes is that the bittersweets contain appreciable quantities of tannin, which substance occurs only in very limited quantity in the sweet varieties. For present purposes these two classes may be treated as one, since their mode of use from a food point of view is identical.

Hitherto it has only been the sour varieties which have been drawn upon to any extent to make good any deficiency in the crop of ordinary table apples. Their utilisation presents no difficulties, the quantity of acid contained being sufficient to furnish the neces-

sary cooking qualities for culinary purposes and the "setting" or "jellying" properties for jam-making. Arrangements were therefore made in the West of England for the 1917 season to deal extensively with this class of fruit for the production of apple pulp for jam making, and the major portion of the apples pulped at the respective centres organised there as well as those dispatched to other stations in other parts of the country were of this type.

The other types, however, have not been utilised previously to any extent on a commercial scale for food purposes and the work in this direction which has been carried out during the 1917 season must, therefore, be regarded as largely of an experimental character. The form of product which it was decided to make was the type of apple jelly evolved as the result of experiments carried out at Long Ashton in 1914. In essentials the method consists simply in concentrating the freshly expressed juice of the fruit until the content of sugar approximates to 65 per cent. The concentration is effected by heat and, when cool, the thick liquor sets to a more or less firm jelly which possesses an intensified apple flavour. Natural apple juice in an average season contains about 10 per cent. of total sugar. The juice, therefore, must be reduced to about 1/7th of its original volume, if no other sugar is added. It is found in practice more economical to add approximately the same amount of sugar as occurs naturally in the juice. The extent of concentration required is then reduced by one-half, a larger yield of jelly is obtained from a given weight of fruit, and there is a considerable saving of time. The quality of the jelly is also considered by most people to be superior. The added sugar may be either cane sugar, glucose, or corn syrup. In most cases during the past season a mixture of equal parts of cane sugar and corn syrup was used and gave very satisfactory results.

Stations.—On behalf of the Food Production Department two centres for the manufacture of this jelly were organised in 1917, viz., at the Research Station, Long Ashton, and at Wedmore, near Cheddar. Long Ashton was selected—in spite of its not being located in a large apple growing district—on account of the facilities for conducting the necessary experiments on the method of making. Wedmore, although awkwardly situated as regards railway service, is in the midst of a large fruit district, and growers were keen to develop a local industry for their cider apples.

At Long Ashton accommodation for the required plant was provided in the cider house at the Research Station, and premises for the storage of the jelly were obtained near the railway at Flax Bourton. The Manager of the Station, Mr. E. P. West, undertook the general charge of the work, the technical side being looked after by Mr. Grove with Mr. Spinks' assistance.

At Wedmore a small house and workshops adjoining were secured

as working premises, and the main storage accommodation was provided at Cheddar Station, the nearest point on the railway. The general management was in the hands of Mr. W. G. Burrough, of Wedmore, assisted by a small local committee, and Mr. Warneford, a member of the staff of the Food Production Department, took charge of the making of the jelly during the greater part of the season.

PLANT.—The requisite plant for jelly-making consists of :—

(*a*) a mill and press, for extraction of the juice from the fruit,

(*b*) an evaporator, for the concentration of the juice.

Mills and Presses.—Ordinary cider mills and presses serve perfectly well.

At Long Ashton an American type of "grater" mill and a hydraulic press, used at the Research Station for cider-making, were available. The yield of juice per ton of fruit with these machines averaged 150–170 gallons according to the period of the season. At Wedmore an ordinary type of "crusher" mill and two small hand-power presses of a primitive type had to be used, insufficient time being available to obtain more efficient apparatus. These were adapted so as to be driven by electric power. The yield of juice per ton of fruit rarely exceeded 120 gallons. This low figure was largely due to the inefficiency of the machines and was one of the chief contributing factors to the relatively high cost of making the jelly at Wedmore.

Evaporators.—It has been possible as a result of the seaons's working to obtain important information as to the most efficient type of evaporator for this particular purpose.

The simplest form is the ordinary steam-jacketed jam-boiling pan. This is the least satisfactory type of apparatus, being open to the objection that, not being a continuous working form, the whole of the juice dealt with in one operation has to be subjected to a high temperature until the volume is reduced to the required point. This involves a relatively long period of cooking with consequent partial caramelisation of sugar and, therefore, considerable darkening of colour and the acquisition of a more or less distinct burnt flavour. The "setting" property of the jelly is to some extent affected. The process is also comparatively slow. The usual type of steam-heated vacuum boiling pan is an improvement, but this form is also open to the same objection of not being continuous in its working. Caramelisation is, however, considerably reduced, and colour and flavour accordingly are improved. The speed of evaporation is increased, but the output does not reach that of a continuous working apparatus.

The evaporator used at Wedmore was one constructed on the lines of certain American juice evaporators. It consists of a long narrow wooden trough divided into two compartments by a partition running nearly the whole of its length. The two compartments

are entirely partitioned off from each other by this at one end, the fresh juice being fed into the one division at this end and the outlet for the concentrated juice being situated at the corresponding point in the other compartment. The two compartments communicate at the far end, where the partition does not extend quite the full length of the trough. The bottom of the trough is made slightly sloping in such a way that the incoming juice flows along the first compartment to its point of communication with the second compartment at the far end and thence returns in the opposite direction along the latter to the point of outlet. Three copper steam pipes are fixed just above the floor of the trough in each compartment and these are heated by steam at 80lbs. pressure. The juice in its flow from inlet to outlet is gradually concentrated, and by regulation of the rate of feed of juice the desired degree of concentration is obtained. A wooden cover is fitted over the whole trough and a central flue to carry off the evolved steam from the boiling juice is provided.

This evaporator has the advantage of being continuous in its working but proved, unfortunately, to be difficult to regulate. Variations in steam pressure affected the rate of flow to such an extent that constant attention was required, and a number of other causes contributed to produce such serious irregularities in the flow that occasionally the steam pipes near the outlet would become partially uncovered, leading to burning of the concentrated juice, while at other times juice incompletely evaporated would be delivered. It was with great difficulty, therefore, that anything approaching uniformity in the product was obtained. The speed of the apparatus proved to be much slower than had been anticipated and the cost of concentration was accordingly relatively high. The quality of the product was, on the whole, fair: the colour was generally rather too dark and the flavour at times showed traces of burning. The jelly as a rule set moderately well, but showed a tendency to be hygroscopic and during damp periods in December liquefied somewhat. Under drier conditions this is now setting again. The principal drawbacks of the apparatus are the slow rate of output, the high cost for concentration and the difficulty of securing uniform working.

The apparatus used at Long Ashton was the Kestner Evaporator. This is a machine extensively used for a variety of chemical and industrial purposes. Since it is somewhat complicated in construction, no detailed description will be given here. In essentials it consists of a continuous series of copper tubes, on the interior surface of which the juice travels as a thin film. The tubes are heated externally by steam under pressure and the juice in its passage through them is gradually concentrated. The most suitable pressure found during the past season's working with

apple juice was about 30lbs. A special arrangement at the delivery end of the tube system provides for the separation of the evolved steam from the concentrated liquid. The machine is a continuous working one. It can be operated with the treated liquid under ordinary or reduced pressure. No vacuum pump was provided for the first season's trials at Long Ashton and consequently the whole of the work was done under ordinary pressure: but there is no doubt that the reduced pressure method would give decidedly superior results both as regards quality of product, rate of yield, and cost of evaporation. For future work in this direction it is likely to be adopted. Another improvement which should in future be incorporated is the pre-heating of the juice before it enters the evaporator. This can be done by a simple addition to the apparatus, by which the heat of the evaporated steam given off by the juice is utilised for raising the temperature of the ingoing juice to boiling point, no addition to the cost of concentration being therefore entailed. Its effect would be in the same directions as those gained by working under the reduced pressure system. A single trial carried out in a rough way towards the end of the season demonstrated this fully.

Method of Making Jelly.—The general method of making the jelly has already been outlined. The actual details of the process, as generally carried out, are appended.

Type of Fruit.—Beginning with the fruit itself as representing the starting point, it is hardly possible to over-emphasize the importance of following as closely as practicable the procedure here laid down in connection with it. The quality of the final product and the yield depend very largely upon it.

The fruit to be dealt with should consist mainly of sweet or bittersweet varieties or a mixture of both types. A limited proportion of sour apples in the mixture is permissible, but it should in no case exceed one-third of the total quantity and not more than one-sixth should be allowed if the jelly is made without added sugar. The object is to secure that the percentage of malic acid in the finished jelly shall range somewhere between 1 and 1·5 per cent. The exact amount desirable is a matter of taste; for most palates, an amount below 1 per cent. results in a jelly too insipid and sickly sweet in flavour, while anything exceeding 1·5 per cent. is too sharp. It is obvious that the degree of acidity requisite in the unconcentrated juice must depend upon the extent to which the concentration is to be carried, *i.e.*, upon the percentage of sugar. Approximately 65 per cent. of total sugar is needed in the jelly: hence the quantity of sugar in the juice before evaporation, whether natural sugar only or natural plus added sugar, determines the extent of concentration required. At Long Ashton it was the practice to test the acidity and the sugar content of every lot of

juice used, adjusting the acidity to the calculated quantity needed by the addition of sharper or less acid juices as the case might be. In purchasing the fruit both for Wedmore and Long Ashton it was specified that sweet and bittersweet varieties only should be supplied, it being anticipated that a sufficient number of sour apples would be accidentally admixed to yield the correct degree of acidity in the juice. This anticipation was to some extent justified by results, but at times it was found that the addition of a further quantity of acid apples was necessary, and in such cases advantage was taken of stocks of such fruit which had been procured for pulping.

Condition of Fruit.—The correct blend of fruit or juice having been indicated, a few notes as to the state of ripeness at which it should be dealt with are desirable. The two principal points involved in this connection are (*a*) the yield of juice obtainable, and (*b*) the " setting " quality of the juice. Both are obviously highly important in connection with the commercial aspect of the manufacture of the jelly.

Experience in the making of cider has shown that the yield of juice is determined by the condition of ripeness of the fruit at the time it is milled and pressed. Both unripe and overripe fruit—particularly the latter—yield less juice from a given weight of apples than fruit which has reached a well-ripened condition. In practice it is impossible in dealing with large quantities of fruit to ensure either an even state of ripeness in each lot handled or the extraction of the juice in every case at the moment when it is capable of giving the biggest yield : but the influence of this point on the financial results is sufficiently marked to make it important to organise supplies of fruit in such a way as to enable them to be dealt with as far as possible while at the best condition of ripeness.

The " setting " quality of the juice is similarly much affected by the state of ripeness of the fruit. The juice from unripe fruit sets less well after concentration than that from perfectly ripe apples and that from much overripe fruit is also apt to give trouble in this respect. Up to a point a certain amount of overripeness may assist rather than hinder the " setting " of the jelly ; and it is probable that the fruit should be left over to a somewhat more advanced state of maturity than is desirable from the point of view of yield of juice, if the maximum " setting " quality is aimed at. It is preferable, therefore, that the fruit should be thoroughly well matured before extraction of the juice, even if a portion is distinctly over-ripe, rather than it should be milled unripe, unless steps are taken to ensure good setting by the use of pectin extract, concerning which information is given below.

Extraction of Juice.—There are no points of particular importance in connection with the extraction of the juice which require notice.

The methods found most satisfactory in cider-making apply equally in this case.

Supplies of Juice.—In preparing quantities of juice for evaporation it is desirable to provide at one time no more than is required for one day's working of the evaporator. Juice more than 24 hours old is liable to show the beginnings of fermentation, particularly during the warmer parts of the season; and, when this occurs, its "setting" qualities suffer owing to changes in its pectin constituents. An attempt was made to overcome this difficulty by treating the juice with sufficient sulphur dioxide to arrest fermentation for a few days: but, although the juice can be retained fit for jelly-making in this way even for so long a period as a fortnight or more, the jelly does not "set" readily and the method cannot be recommended except for emergencies caused by an over-supply of juice. This is bound to occur from time to time owing to the necessity of milling without delay occasional stocks of apples showing serious signs of over-ripeness.

At the same time it is desirable to provide at the start of each day a sufficient bulk of juice to last throughout the day. If this is pumped into one large vat, it ensures that the whole of the day's output is of uniform character, a point of considerable importance, since in dealing with separate small lots of juice from mixed fruit it is inevitable that appreciable variations will occur. At Long Ashton two blending vats, holding about 750 gallons each, were used, the contents of the two sufficing to keep the evaporator running for a working day of about 15 hours.

Standardising Acidity of Juice.—The acidity of the supply of juice provided is brought to the required standard by blending as already described. It has been shown that this standard is determined by the degree to which concentration is to be carried, *i.e.*, according to whether sugar is or is not added. As mentioned in the beginning of this report, the method found most advantageous is to raise the content of total sugar in the unconcentrated juice to approximately 20 per cent. by the addition of cane sugar or corn syrup or a mixture of both, in which case the standard of acidity is taken as about ·35 per cent. of malic acid and concentration is carried to about 2/7ths of the original volume.

Use of Sugar.—When supplies of sugar in some form are available, its use is advised for the reasons already given. If cane sugar is exclusively used, the flavour of the jelly is sweeter and its consistency generally firmer. Corn syrup alone, consisting of a mixture of glucose, maltose and dextrin, yields a less sweet article and there is a tendency for the jelly to show a more sticky or treacly consistency. A mixture of cane sugar and corn syrup in equal parts gives results little, if any, inferior to cane sugar alone.

Jelly made without added sugar is more intense in flavour, its colour is deeper, and particular care to avoid caramelisation during the making is necessary. It is, however, possible to make a palatable article without added sugar; and the only serious drawbacks to this method are that the yield of jelly from a given weight of fruit is considerably less and that when the price of apples is about £3 per ton or upwards the cost of the jelly works out at a slightly higher rate than that resulting when added sugar is used. The latter point simply resolves itself into a question of relative prices of apples and sugar.

In using added sugar or corn syrup special provision has to be made for dissolving this material in the juice. When it is added directly to the juice in bulk a serious loss of time occurs owing to the very slow rate of solution at the low temperatures prevailing during autumn and winter. Corn syrup especially is difficult to deal with in this respect. Hot juice quickly dissolves both cane sugar and corn syrup, but the bulk of juice required for the day's working is too large to permit of preliminary heating simply to dissolve the sugar, on account of the expense attached. An easy method of effecting solution and the one adopted at Long Ashton and Wedmore is to heat the quantity of sugar required with a comparatively small volume of juice in a steam-jacketed jam-boiling pan. Very little time is needed for complete solution. When the whole of the sugar is dissolved, the thick syrupy liquid is pumped into the main body of cold juice and thoroughly mixed with it by stirring. The jam-boiling pans can be heated with waste steam from the evaporating plant and no additional cost is involved.

At the beginning of the season the question as to whether it is better to add the sugar before or after concentration of the juice was given attention. The chief point in favour of the latter course is that less steam is required for concentration. It was found, however, that it was not easy to dissolve the sugar and obtain an even mixture in the thick syrupy concentrated liquid, and consequently the simpler method of addition before evaporation was adopted.

Use of Pectin Extract. There remains one further point to be dealt with before passing on to details of evaporation, viz., the steps which have to be taken to ensure the satisfactory "setting" of the jelly after concentration.

The investigations on pectin compounds which have been conducted at Long Ashton during the past four years have shown that the following three conditions are necessary for a proper "gel" formation, viz,, (*a*) the content of total sugar present in solution—whether cane sugar, glucose, or some other suitable carbohydrate, either singly or in mixture—must

approach 60–65 per cent.*, (*b*) an acid of some kind, preferably malic, citric or tartaric, must be present in quantity approximating at least to the equivalent of 1 per cent. malic acid, and (*c*) a suitable form of " pectin " must also be present in quantities of ·5 per cent. or upwards. In many samples of apple juice dealt with in the course of this work, with the acidity raised to the standard adopted as being most suitable for jelly-making, these three essential conditions were easily obtained in the finished product when the fruit handled was in reasonably uniform condition as regards ripeness and was milled when well ripened. Even when the fruit was somewhat over-ripe no serious trouble was experienced; but badly over-ripe fruit as well as unripe or unevenly ripe samples caused uncertain results, mainly on account of pectin deficiencies. Since in practice the condition of the fruit generally is very variable, it was considered advisable during the greater part of the season to add a limited quantity of a pectin extract to the juice before evaporation.

The extract was made by passing waste steam from the evaporator into a mass of pressed apple pomace, plentiful supplies of this being, of course, always available. After being steamed for some time the mass was placed under the press and as much liquid as possible extracted. This fluid, which was thick and mucilaginous in character, contained considerable quantities of pectin and was added to the juice at the rate of 15 gallons of extract to 100 gallons of juice. When this method was adopted, the jelly could be relied upon to set well, provided that the juice was not overcooked in the evaporator.

With the extract an additional quantity of sugar was used (15lbs. of sugar to 15 gallons of extract) to avoid dilution of the juice in respect of that constituent.

The use of a crude pectin extract prepared in the manner described is mainly for the purpose of ensuring the proper " setting " of the jelly: but it also affects the yield from a given weight of fruit. Practically it amounts to the addition of 15 per cent. to the volume of the fresh juice handled with a corresponding gain in the final amount of jelly. It occasionally results in a still greater increase in the yield of jelly, since some juices without it have to be concentrated to a smaller bulk than that normally requisite in order to give a sufficiently firm " set." The question of cost of production does not appear to be materially affected because, although a ton of fruit will yield a higher percentage of jelly, an increased amount of sugar is used. The daily output of the evaporator is substantially the same whether the juice contains added pectin extract or not. On paper jelly with added pectin should be produced rather

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* It has recently been found that a definite " gel " can be obtained with dextrin in place of sugar. This fact is of significance when corn syrup is used. A 30% solution of dextrin is capable of yielding a firm jelly.

more cheaply, but in a limited trial made at Long Ashton this anticipation was not realised. Further tests, however, must be made before a definite conclusion can be drawn.

Some preliminary experiments with an improved form of pectin preparation suggest that an appreciable reduction in the cost of production should be possible, provided that the value of sugar as compared with that of the fruit does not vary materially from the ratio obtaining during the 1917 season. The preparation in question also promises to simplify the problem of making the jelly set and to yield a superior product.

From the point of view of flavour the addition of the pectin extract has no pronounced effect. The strength of the flavour is very slightly reduced, so slightly as to be practically inappreciable. The acidity is also slightly reduced, but this can be very simply adjusted by modifying the standard of acidity in the unconcentrated juice by suitable blending.

Clearing of Juice.—The fresh juice as it is received from the press is a turbid liquid containing variable amounts of particles of apple pomace in suspension. The removal of the coarser particles is essential and is readily accomplished by straining the juice, as it is pumped into the blending tank through a filter bag made of canvas or other suitable material of moderately fine mesh. By that means the juice, while still turbid in appearance, is freed fairly completely from suspended solid matter, the turbidity being mainly caused by pectin compounds in solution. A further filtration of the juice is arranged as it is fed to the evaporator, the end of the suction hose of the supply pump being covered with fine-meshed straining cloth.

The turbidity of the juice disappears almost entirely in the final stages of its concentration in the evaporator. This is believed to be due to the interaction of the sugar, acid and pectin contents, and the comparatively sudden change from opacity to relative transparency which occurs apparently at or about a given point of concentration is regarded as indicating that the "jellying" stage has been reached. In practice it constitutes a safe guide.

The jelly prepared in this way without more elaborate attempts at clearing is semi-transparent when cold, a certain amount of haziness developing as it cools. Attention is being given to the preparation of an absolutely brilliant jelly: but it is doubtful if this can be produced without the use of a costly and elaborate filter.

Concentration of Juice. The forms of evaporator used at Long Ashton and Wedmore having already been described, comparatively little need be added here as to the details of concentration.

A supply pump provides a continuous flow of juice into the evaporator, the rate of which can be regulated as required. This is determined by the specific gravity of the concentrated juice. It is considered necessary that the jelly should possess a total sugar

content of 60-65 per cent. to ensure adequate keeping and setting properties. This is equivalent to a specific gravity of 1·350 (or about 70° Twaddell) at 15°C., which corresponds to a density of about 60° Twaddell at the temperature of the concentrated liquor as it is collected from the evaporator (about 95°C.). The whole rate of working of the apparatus is therefore controlled by the specific gravity readings of the concentrated juice. They are taken at frequent intervals with a hydrometer, the standard gravity adopted being 60° Twaddell for the hot liquor. When the gravity reading is too low the rate of supply of juice to the evaporator is slowed down, and when it is too high the supply is increased.

There is another means of controlling the rate of concentration, viz., by regulation of the steam pressure of the evaporator, an increase in this pressure resulting in an equivalent increase in concentration.

By the combination of this method with that of regulation of the supply of juice it is not difficult with the Kestner apparatus to maintain the specific gravity of the concentrated liquor at any point required. Control is similarly obtained with the American type of evaporator used at Wedmore, but exact regulation is more difficult and closer and continuous attention is needed in this case.

Treatment of Concentrated Juice.—In view of slight variations in the specific gravity of the concentrated juice as it flows from the evaporator it has been found better to collect the liquor in a fair-sized wooden vat rather than to run it directly into the final receptacles. By doing so small temporary fluctuations in specific gravity have no material effect, since the specific gravity of the whole contents of the vat is adjusted to the required standard before the jars are filled, by making up with juice of a somewhat higher or lower gravity as may be required.

Receptacles.—As regards receptacles, two kinds have beer used, viz., glazed earthenware jars and waxed papier maché pots. The concentrated juice, when the latter are used, should be cooled to 65°C. or even lower before it is placed in them, to avoid melting the paraffin wax with which the vessels are rendered waterproof.

After the receptacles are filled the juice is allowed to cool and set to a jelly before covers are put on. The exposure of the surface of the cold jelly does not appear to involve any risk of trouble with mould growth subsequently. No sign of mould has ever been observed on the jelly, even in cases when the article has been left standing without any form of cover for over three years. Nor has any instance of fermentation been recorded. The keeping quality of the jelly is, therefore, probably exceptionally good.

Storage.—The only point in connection with the storage of the jelly which requires mention is that an atmosphere as dry as possible is preferable until the jars have been finally covered down.

The jelly is in some cases slightly hygroscopic, probably on account of the presence of laevulose (fruit sugar). It consequently absorbs moisture slowly in a damp atmosphere and the surface becomes slightly liquid. This soon passes off when the jars are placed again in a dry room.

Statistics.—Owing to delay in getting the plant fixed at Long Ashton and Wedmore it was not possible to start serious work at either place until towards the end of October: and then the first fortnight or so was largely occupied in working out the best methods of procedure. However, a sufficiently long period of the apple season was available to enable satisfactory statistics as to the capacity of the machines and the cost of production to be obtained.

Output.—As regards output the Kestner evaporator at Long Ashton was capable of dealing with 100 gallons of the prepared juice per hour under fair average conditions of working, giving an average production of about 275lbs. of jelly per hour. Under specially favourable conditions the quantity of juice per hour used advanced occasionally to 110–120 gallons. These figures refer to cold juice only In a trial where the juice was pre-heated to 75°C. before entering the evaporator the juice supply per hour easily reached 125 gallons. Probably an appreciable increase in these figures would have been recorded, had a larger steam boiler been available. That used had to be run at full capacity the whole time in order to maintain the steam pressure in the evaporator near 30lbs. per sq. inch.

The evaporator at Wedmore was considerably inferior in capacity, dealing with not more than 30–40 gallons of juice per hour, with a production of 80–100lbs. of jelly per hour. In this case, the juice was pre-heated in a special chamber of the apparatus before passing to the evaporator proper, and the working steam pressure in the latter was about 80lbs. per sq. inch: so the greater efficiency of the Kestner type of machine is clearly demonstrated.

The total output of jelly for the season at Long Ashton was approximately 156,000lbs., and at Wedmore 56,000lbs., a weight of approximately 350 tons of apples being dealt with at the former station and 210 tons at the latter.

Finance.—The accounts for the season's working not being yet complete and further expenditure still being incurred in connection with the packing and consignment of the produce, it is not possible at present to furnish a complete financial statement. A fair idea of the actual cost of manufacture of the jelly can, however, be given. At Long Ashton, on account of cider-making being in daily progress there, no separate records of the cost of milling the fruit and extraction of the juice could be kept; but calculations based upon the average price of the fruit for the season, the daily output of juice and cost for power and labour showed that a charge of 6d. per gallon for juice supplied to the evaporator would fairly meet the

case. At Wedmore, since the jelly-making work only was in hand it was possible to get a series of actual figures for the yield of juice and the cost of milling and pressing; and the exact cost per gallon of juice supplied to the evaporator was thus obtained. To those interested in the question from a commercial point of view the Wedmore figures are unfortunately of little real value, since the mill and presses were not of modern type and gave a low yield of juice at a very high cost of production, and in addition the evaporator used was considerably inferior to the Kestner type as regards cost of production of jelly as well as of quality of product. No useful purpose, therefore, would be served by consideration of the Wedmore statistics in detail. The actual average cost of juice per gallon supplied to the evaporator worked out there at approximately 7d.

The cost of conversion of the juice into jelly fluctuated somewhat at both centres at different periods of the season, and also varied appreciably from day to day. To a considerable extent this was doubtless due to variations in the quality of the juice, but the opinion of those working the machines regularly was that the rate of evaporation and, therefore, its cost were materially affected by atmospheric conditions.

To obtain, therefore, a fair idea of cost of production of the jelly it is necessary to take the statistics for the season as a whole. Even then the result is open to a certain amount of criticism; firstly, because the whole season's work was necessarily somewhat experimental and costs accordingly were higher than they would otherwise have been; and, secondly, owing to the relatively late date of starting work, the main output was produced in the latter part of the season, when, as experience showed, the cost of production rises on account of natural causes.

The accompanying table A, showing the Long Ashton statistics for the season up to January 3rd, 1918, when jelly-making ceased, is the most complete which can be given until the jelly is finally disposed of. It should be noted that it does not include management and establishment charges nor costs in connection with packing or railway carriage. Corresponding statistics for Wedmore are not yet available.

TABLE A.

PARTICULARS OF COST OF MATERIALS AND WAGES FOR MAKING 156,246LBS. (147,056 POTS OF 17OZS. EACH) OF JELLY.

Juice and Pomace Extract	£1,416	13	3
Sugar and Corn Syrup	1,299	18	4
Pots	658	0	2
Wages (Total to January 3rd, 1918) ..	188	8	2
Coal	138	14	3
Jam Covers and Miscellaneous Materials ..	82	16	10
	£3,784	11	0

This figure works out to 5·81d. per lb.

Table B gives corresponding particulars for two individual weekly periods, and Table C for the daily results during a single week.

TABLE B.

Summary for Week Ending	November 24	December 1
Juice used	5,208 gals.	7,080 gals.
Cost of Juice..	£130 4s. 0d.	£177 0s. 0d.
Cost of Pomace Extract added in proportion of 15% ..	£1 9s. 2d.	£1 18s. 6d.
Sugar used	2,377lbs.	2,908lbs.
Corn Syrup used	3,785lbs.	4,739lbs.
Cost of Sugar and Syrup ..	£128 7s. 6d.	£159 6s. 3d.
Labour	£9 18s. 6d.	£11 14s. 0d.
Coal (estimated)	£10 1s. 6d.	£10 1s. 6d.
Pots filled	14,559	18,696
Cost of Pots	£60 13s. 3d.	£77 18s. 0d.
Total cost of materials & making	£340 13s. 11d.	£437 18s. 3d.
Output	15,469 lbs.	19,862 lbs.
Cost per lb.	5·285d.	5·34d.

TABLE C.

STATEMENT SHEWING PRODUCTION OF APPLE JELLY AND COST THEREOF FOR WEEK ENDING SATURDAY, NOVEMBER 24TH, 1917.

	Monday.	Tuesday.	Wednesday	Thursday.	Friday.	Saturday.	Total.	Daily Average.
Gallons of Juice used ..	677	877	918	900	910	926	5,208	868
Cost of Juice @ 6d. per gallon ..	£ s. d. 16 18 6	£ s. d. 21 18 6	£ s. d. 22 19 0	£ s. d. 22 10 0	£ s. d. 22 15 0	£ s. d. 23 3 0	£ s. d. 130 4 0	£ s. d. 21 14 0
Cane sugar used (in lbs.)	272	339	424	442	450	450	2,377	396·16
Corn Syrup used (in lbs.)	522	670	791	593	595	614	3,785	630·83
Cost of Sugar and Syrup @ 5d. per lb.	£ s. d. 16 10 10	£ s. d. 21 0 5	£ s. d. 25 6 3	£ s. d. 21 11 3	£ s. d. 21 15 5	£ s. d. 22 3 4	£ s. d. 128 7 6	£ s. d. 21 7 11
Cost of Pomace Extract used in proportion of 15%	s. d. 3 9	s. d. 4 11	s. d. 5 2	s. d. 5 1	s. d. 5 1	s. d. 5 2	£ s. d. 1 9 2	s. d. 4 10
Labour	£ s. d. 1 13 1	£ s. d. 1 13 1	£ s. d. 1 13 1	£ s. d. 1 13 1	£ s. d. 1 13 1	£ s. d. 1 13 1	£ s. d. 9 18 6	£ s. d. 1 13 1
Coal (estimated) ..	1 13 7	1 13 7	1 13 7	1 13 7	1 13 7	1 13 7	10 1 6	1 13 7

TABLE C—*continued.*

	Monday.	Tuesday.	Wednesday	Thursday.	Friday.	Saturday.	Total.	Daily Average.
No. of Pots ..	2,007	2,372	2,644	2,472	2,518	2,546	14,559	2,426·5
Cost of pots @ 1d. each	£ s. d. 8 7 3	£ s. d. 9 17 8	£ s. d. 11 0 4	£ s. d. 10 6 0	£ s. d. 10 9 10	£ s. d. 10 12 2	£ s. d. 60 13 3	£ s. d. 10 2 5
Total cost of materials and making ..	£ s. d. 45 7 0	£ s. d. 56 8 2	£ s. d. 62 17 5	£ s. d. 57 19 0	£ s. d. 58 12 0	£ s. d. 59 10 4	£ s. d. 340 13 11	£ s. d. 56 15 7·83
Output in lbs. of Jelly	2,133	2,520	2,809	2,627	2,675	2,705	15,469	2518·16
Cost per lb.	5·1d.	5·37d.	5·37d.	5·29d.	5·257d.	5·28d.	5·285d.	5·277d.

THE CIDER INDUSTRY IN RELATION TO PRESENT FOOD PROBLEMS.

By B. T. P. Barker.

The following article would in normal times be out of place in its position here in the Report on the work of the Station not being a record of any particular investigations and only in part a medium for suggestions of turning results of previous experiments to practical account. Its inclusion may, however, perhaps be justified on the ground that the questions with which it deals are mainly urgent and closely concern all sides of the cider industry, while the Report of the National Fruit and Cider Institute is the most likely publication to reach those interested.

Some of the questions which arise are likely to be regarded as highly contentious, and expressions of opinion here offered must not be taken as the considered views of the National Fruit and Cider Institute as a body representing all sides of the industry, but simply as the personal ideas of the writer.

It is obvious that the present position of the cider industry is a very critical and difficult one. On the one hand, its opportunities were never greater. The restriction on the output of beer has resulted in a largely increased demand for cider and perry, and many who before the war were practically unacquainted with them have now become regular consumers. There is every opportunity, then, for establishing those beverages in a strong recognised position and all makers would naturally like to raise the standard of quality of their product to the highest possible point. On the financial side also there is every encouragement for the industry in spite of the taxation recently imposed on the articles. Under such circumstances the aim of the maker is a maximum output. On the other hand, it must be recognised that in a time of food scarcity it is at least debateable to what extent material of potential food value normally used for the production of fermented drinks can be justifiably utilised for such purposes, which result in the destruction of nutrient substances. This point has been already warmly contested in the case of beer and a definite limit on the use of barley in brewing has been imposed. Hitherto the matter has not arisen seriously in connection with cider and perry fruit. Until 1917 adequate supplies of fruit of

all kinds for all dessert, culinary, and jam requirements were available and there was accordingly no occasion to draw materially on supplies of cider and perry fruit. In 1917 it became clear that suitable fruit of any kind would be needed for jam production to carry on until the fruit season of 1918, and accordingly large quantities of sour cider apples were pulped for jam-making by the Fruit Preserving Section of the Food Production Department and the jam manufacturers. Also some 500–600 tons of sweet and bittersweet apples were converted into jelly, as already described in an earlier section of the present Report. The exceptionally heavy crop, however, prevented these calls on the supplies being felt by cider-makers to any serious extent. Looking forward to the coming season the position is altogether different. It is unlikely that there will be a heavy fruit crop. At the same time the need of fruit for jam and jelly making will in all probability be considerably greater. It may be presumed that the consumption of cider and perry will increase rather than diminish. There is, therefore, every likelihood of a situation arising in which there will be marked competition for supplies of fruit for cider and perry making and for food production respectively. For that reason it seems desirable to review the whole situation with the object of seeking a way by which the industry can assist to the fullest extent in the national emergency with the least possible detriment to its present position and future outlook.

In this connection it must be fully realised that the matter is not merely one of diversion of a certain tonnage of fruit from cider and perry making to jam and jelly making. The total crop represents the produce of approximately 100,000 acres of grass land in the West of England, and the fundamental question is to what extent this acreage is bearing or can be made to bear its fair share of the burden now laid upon all land fit for crop production.

Two more or less distinct subjects arise from this. Firstly, that of the manner of utilising the fruit to best advantage for present needs: and, secondly, that of dealing with the orchards so as to ensure a maximum return in crops of real value.

Methods of Utilising Cider and Perry Fruit.

Dealing with the former subject first, it resolves itself very largely into a consideration of the question as to the extent to which cider and perry fruit should now be used for cider and perry making. It will be convenient to take the cases of sour or sharp fruit and the sweet and bittersweet varieties separately, not because both classes cannot be turned to advantage as food, but chiefly because, while the former have always been regarded us utilisable for that purpose, it is only as the result of recent work that sweet and bittersweet fruit have been shown to be of value in that respect.

All sour apples of fair size can be used for culinary purposes quite satisfactorily without any special treatment, while smaller specimens serve for jam and jelly making. So long as there is any demand for them for such purposes during the existing period of food shortage, it is difficult to see how a strong case can be made out for their use in cider and perry making, if it can be shown that palatable and non-injurious forms of those beverages can be made without them.

During recent years at least the cider-maker has come to regard the use of a certain proportion of sharp fruit as indispensable, and with good reason, since a certain degree of acidity in the product is required both for flavour and also to prevent disorders such as sickness and ropiness. Without this degree of acidity the beverage cannot be relied upon to keep sound unless a preservative is added. But is it not possible to obtain the requisite acidity by other means? At the present time, when the use of substitutes must be acknowledged to be justified and necessary in many forms of food and drink, rigid adherence to pre-war ideas as to what is or is not legitimate in cider and perry making cannot be maintained. For that reason it is suggested that sharp fruit should be replaced as far as may be necessary by suitable acids, such as citric or tartaric, or any of the non-injurious composite acid mixtures, such as are largely used to-day in the mineral water trade. Assuming that the juice dealt with was obtained exclusively from sweet and bittersweet fruit, this would in the average case possess a natural acidity of ·2—·3 per cent. malic acid and only an addition of ·3—·4 per cent. of one of the substitute acids specified would be required to give the product all that is necessary in the way of flavour and keeping properties. In the face of this it can hardly be maintained that sharp fruit must be used, and it certainly seems that the claims on supplies for jam-making and culinary purposes should receive first consideration.

It is only as the result of recent work at Long Ashton that sweet and bittersweet fruit comes up seriously for consideration from the food point of view. As described in the various Reports of this Station issued since the start of the war, it is now possible to use such fruit either for culinary or jam purposes or for jelly making. That being so, it may be argued on similar lines as above that the whole of this class of fruit also ought to be ear-marked as far as needed for food purposes. The only reason for attempting to draw any distinction between the position of this and that of sharp fruit is that the latter can be utilised for food directly without any special treatment, while the former requires suitable methods. However, the fact that it can be utilised means that the cider-maker may, like the brewer, have to be content with limited supplies. In that event how best could the situation be met?

From the point of view of the welfare of the industry, more particularly with regard to its future position, it seems important

that the supplies of cider and perry to the general public should as far as possible be maintained. In other words, attention should be concentrated on production for commercial purposes rather than for home use on farms. The practice of providing cider for farm labour has in many cases been abused, and recently there has been considerable controversy on the subject. Under the circumstances would not the best way out of the difficulty be for cider and perry to be made only for sale, except, possibly a limited quantity for use in the farmhouse itself? A small proportion for farm labour might, where desired, be reserved in addition, the necessary bulk being made up by heavy dilution with water. By some such method a considerable quantity of these products which never normally reaches the market would be available for the general public.

The other method of maintaining supplies which merits consideration is that of abandoning for the time being the production of pure-juice cider and perry,—except possibly in special cases—substituting for it a diluted form of beverage. A perfectly palatable and wholesome drink can be made in many cases simply by the addition of a limited quantity of water. In other cases, where the pure juice is too weak to permit of this being done satisfactorily, the best plan would probably be to bring up the specific gravity of the freshly pressed juice—after dilution with the desired amount of water—by the addition of the requisite quantity of corn syrup, adding also at the same time a suitable amount of one or other of the acids above specified if the degree of acidity was otherwise too low. Quantities of a lower-grade but palatable beverage could also be made on similar lines by extracting the pressed pomace with water and bringing the standard of the extract up to a suitable point of addition of corn syrup and acid.

By proceeding along the lines indicated the output of cider and perry for general consumption could be more or less well maintained with probably no serious detriment to the industry as a whole, and a very large proportion of the fruit crop would be available for food production.

There is no occasion here to go into detail as to the various uses to which this fruit could be put, these having been dealt with individually at some length in this and other recent Reports. They may be summarised as follows :—

Apples and pears of the sharp class :—

Jam and fruit pulp.
Culinary use.

Apples and pears of the sweet and bittersweet classes :—

Jelly (by the juice concentration method).
Apple and Pear Syrup (by concentration of juice).
Jam (by addition of acid).
Culinary use (by addition of acid).

The value of cider and perry fruit is not, however, exhausted with the various uses already specified. The pressed pomace is an article of material value and can be put to a variety of uses. These again have been enumerated in recent articles and need not be enlarged upon here. It is a useful food, wet or dried, for cattle and pigs, and every effort should be made by individual cider-makers to see that all not required for other purposes is put to use in this direction. It can be used for vinegar making, and with the prospect of a shortage of malt vinegar there seems a distinct opening both for inferior cider and perry and also pressed pomace for this purpose. It is also likely that next season means will be found to utilise it in jam making on a commercial scale, both for the production of pulp for jam and also as a source of pectin : and these uses may ultimately prove to be the most important. Finally the residues from the latter processes as well as the pressed pomace itself are of value as an organic form of manure.

The Improvement of Grass Orchards.

Passing on now from the subject of utilisation of the fruit to that of the orchard problem its importance may be realised by reference to the most recent returns of the Board of Agriculture and Fisheries, which show that in the western counties there are approximately 100,000 acres scheduled as apple and pear grass orchards. By far the greatest proportion of this land is nominally occupied with cider and perry fruit ; but it must be borne in mind that many of these orchards exist in little more than name now, so few trees remaining and those so degenerate. But, making due allowance for that, it is clear that a large area of valuable land—for most of the orchards are located on really good soil—is taken up with cider and and perry trees, and it must be admitted by all who are familiar with the conditions that proper value is not being obtained from that land. Not only are many of the orchards now sparsely stocked with trees, and not only are a seriously large proportion of the trees worn out or crippled, but also many of the more vigorous trees are of absolutely inferior and almost worthless varieties. At an early date the question of the restoration and renovation of these orchards will have to be taken in hand and a definite movement in that direction may shortly occur. There is no occasion here to do more than outline the various lines of action which can be taken.

In the first place a thorough survey of the orchards is needed to show (*a*) which varieties are worth preserving and which should be discarded, (*b*) which orchards are worth restocking, and (*c*) which individual trees should be left untouched, which removed and replaced, and which re-worked with selected varieties of real commercial value. With this information available an organised programme of orchard improvement could be planned and carried

out. Apart from orchard improvement the effort would almost certainly be thoroughly justified by bringing to light local or practically unknown varieties of real value.

In the second place efforts should be made to invigorate the existing trees. The majority at present are harbours for pests of all kinds, and as such are a serious nuisance for all serious fruit culture in the locality. A simple form of cleansing winter wash would yield results out of all proportion to the outlay and trouble necessitated. Again, the fact that the orchards are on grass land means that the trees are exposed to the injurious action which Pickering's experiments at Woburn and elsewhere have demonstrated to be exerted by the grass. While it may be admitted that this toxic grass effect varies considerably in extent in individual orchards,—the experimental work carried out by this Station has demonstrated this for the West of England—its existence must be regarded as established, and there are undoubtedly many trees in an unhealthy condition simply because they are planted in grass. In the case of comparatively young trees the removal of the turf for an area of from three to six feet radius around the base of the stem would cause frequently marked renewal of vigour. There are probably special cases where it would be profitable to cultivate a portion of or perhaps the whole orchard, growing a suitable food crop on the land thus provided. Where cultivation is out of the question attention should be given to the use of the orchards for grazing purposes. Improvements in the condition and quality of the herbage could in many cases be effected, and the result would be of mutual benefit to the stock fed thereon and also to the trees.

While these suggestions have to do with the trees themselves and only through them with future actual crops of fruit, much more could be made of the present crops of fruit produced. The quantity of fruit which is allowed practically to run to waste is far greater than need be in very many instances. A limited amount of loss of fruit in a grass orchard is possibly unavoidable: but no excuse for not attempting to harvest the crop in good condition should be allowed to hold when fair prices are obtainable. In spite of labour difficulties it has been possible to get in the fruit in good condition when the grower seriously attempted to do so: and, if supplementary help is needed, local organisations for fruit picking and gathering can be arranged. The need for fruit will be such that any grower neglecting to harvest his fruit properly may run the risk of being penalised.

A great waste of fruit also commonly occurs after it has been collected. It is allowed to lie about the orchards or in store until over-ripe and frequently more or less rotten: and its value is accordingly largely depreciated both for cider-making and any other purpose. It must also be regarded as a waste of fruit when cider

and perry inferior in quality to that which could be obtained by proper treatment is produced. Much of the cider and perry made on the farms falls under this head. In stating this there is no intention of decrying farm-made cider. On the contrary it is fully admitted that in certain cases some of the best and purest cider is made on the farm. Nevertheless, owing to a variety of circumstances it seems to be inevitable that a large proportion of farm-made cider is unnecessarily inferior in quality. The most promising suggestion of dealing with this form of waste appears to be the establishment of co-operative cider factories by the farmers in suitable centres. It is encouraging to find that this idea is meeting with support in several quarters and only the intervention of the war has prevented their establishment in certain centres.

In conclusion, it is desired particularly to emphasize again the point that the time has arrived when the cider and perry orchards of the West of England must be dealt with. They represent far too large an area of land to be permitted to remain in their present unsatisfactory and relatively unproductive condition. The interests of the cider industry are so closely concerned that it is most important that its requirements should be clearly defined and recognised : unless this is ensured, it may find itself before many years have elapsed faced with a regular shortage of fruit. The suggestions put forward here for keeping up the output of cider are, of course, merely intended to tide over the present emergency and not to meet any permanent shortage of the cider fruit crop. The whole position needs most careful consideration and a considerable revision of present conditions and practice may be necessary for the future development of the industry.

A JOINT POTATO VARIETY TRIAL.

By B. T. P. Barker.

It has for some time been recognised that the hitherto prevailing system of conducting variety trials of agricultural and horticultural crops in this country has failed to yield results commensurate with the amount of effort expended. This partial failure has been due primarily to the fact that in the great majority of cases there has been far too little co-ordination between individual trials of a similar character. Most institutions and other bodies conducting the trials have worked more or less on lines of their own, with the result that satisfactory comparison between individual trials has been rendered almost impossible. The establishment a few years ago of Provincial Advisory Councils throughout the country promised considerable improvement in this direction, but the war has for the time being curtailed their activities. However, at the Potato Conference at Ormskirk, under the auspices of the Board of Agriculture and the Lancashire Farmers' Association, in October, 1916, Mr. W. Cuthbertson, V.M.H., of the firm of Dobbie & Co., undertook to organise a potato variety trial under standardized conditions, and this was carried out in 1917 at ten centres throughout the country by the following :—

Professor Seton, The University, Leeds.
Dr. Keeble, F.R.S., Director, R.H.S., Wisley.
Mr. W. D. Davidson, Department of Agriculture for Ireland.
Mr. W. Mauger (Mauger & Son), Guernsey.
Mr. P. C. M. Veitch (Robert Veitch & Son), Exeter.
Mr. E. J. Deal (Johnsons, Ltd.), Boston, Lincolnshire.
Mr. Sowman, Lancashire C.C., Hutton.
Mr. G. T. Malthouse, Shropshire C.C., Shrewsbury.
Mr. James Bone (Dobbie & Co.), Edinburgh.

The tenth centre was at the Research Station, Long Ashton, the work there being under the charge of Mr. H. Locke.

Twenty varieties of potatoes were tested, twenty sets of each.

The seed was as uniform in character as it was possible to obtain, having all been grown in a market garden near Edinburgh in 1916, and previous to that in various parts of Scotland. All varieties were grown in rows 3 feet apart and the sets placed 18 inches apart in the rows. The ground at each centre was prepared during the winter by being dug one spit deep and manured with farmyard manure at the rate of 20 tons per acre. All seed was boxed and sprouted prior to planting, the latter being accomplished by Easter, 1917. At the time of planting artificial manure on the basis of a 6 cwt. dressing per acre (1 cwt. sulphate of ammonia, 1 cwt. sulphate of potash, 4 cwt. 26% superphosphate) was applied in the rows. The precaution of planting one or two rows at each end of the trial plot with a variety not in the trial was adopted.

All seed and artificial manures were provided by Mr. Cuthbertson, who also collected all information as to the results at the respective centres and prepared a report upon them which was recently published in the Journal of the Royal Horticultural Society (Vol. XLIII). The following details are taken from that report. Thanks are due to Mr. Cuthbertson for permission to use them and to the Royal Horticultural Society for sanction to reprint.

Before passing on to them attention may be more particularly directed to the comparatively uniform manner in which individual varieties stand in order of merit at the various centres and also to the striking yields of the first early varieties as compared with the second earlies and maincrops. Doubtless the weather was partly responsible : but it is evident that they are not always markedly inferior in yield, as many authorities assume. It will probably be generally agreed that the results thoroughly justify all the trouble taken by Mr. Cuthbertson, and fully bear out the view of the importance of standardization and co-ordination in trials of this character.

" *Nature of Soils, etc.*—The following particulars furnished by the growers will indicate the nature of the soils on which the potatoes were grown. The localities are given in the same order as in the table.

1. Guernsey. The soil is of a very sandy nature and has carried bulbs for many years. It was reclaimed from the sea in 1812, and up to twenty-five years ago produced little. When it came into the present possession it was drained and many thousands of loads of sandy road sweepings were added. It lies eight feet above sea level.

2. Edinburgh. Free loam on market garden land at Joppa, four miles east of Edinburgh.

3. Bristol. Sandy to medium loam, with a tendency to stickiness on surface after heavy rain and caking on drying, at Long Ashton, four miles west of Bristol, 160 feet above sea level. Followed nursery apples.

Yield of Potatoes in Lbs.

	Guernsey.	Edinburgh.	Bristol.	Leeds.	Wisley.	Boston Lincs.	Co. Down, I.	Exeter.	Preston.	Salop.	Total.
Early Varieties.											
Sir J. Llewelyn ..	71	72	88	89	75	76	81	63	65	66	746
*Snowdrop (Resistant)	60	61	64	58	59	75	72	58	53	54	614
Sharpe's Express ..	55	63	66	64	58	77	66	48	54	55	606
Witch Hill	65	62	56	59	55	75	66	50	53	44	585
Midlothian Early ..	64	47	22	49	56	34	46	23	49	38	428
Second Early Varieties.											
British Queen ..	90	87	87	80	87	94	79	78	54	63	799
*Great Scot	80	94	93	69	46	42	54	36	44	35	593
*Secundus	75	45	92	50	42	59	46	76	29	53	567
*Burnhouse Beauty	60	60	43	55	56	57	56	48	51	42	528
*Dobbie's Favourite	73	75	31	65	61	26	53	29	47	19	479
Main Crop Varieties.											
Dobbie's Prolific ..	115	79	65	54	74	66	63	61	53	38	668
*The Provost ..	64	79	90	52	71	70	52	70	48	54	650
The Factor	80	77	51	68	79	53	77	56	74	28	643
King Edward ..	48	68	88	71	67	80	61	50	30	38	601
*The Admiral ..	71	48	83	57	50	68	29	79	44	47	576
*Kerr's Pink ..	77	85	50	67	66	52	51	47	43	31	569
Arran Chief	45	54	40	59	61	52	55	77	55	34	532
Isis	59	65	55	59	52	55	39	44	47	23	498
*White City.	36	56	46	58	62	56	44	56	44	30	488
*The Lochar	52	60	45	55	41	32	44	46	39	22	436
Total ..	1340	1337	1255	1238	1218	1199	1134	1095	976	814	11,606

* Resistant to Wart disease.

4. Leeds. Medium loam soil overlying coal measure sandstone, at Garforth Manor Farm, eight miles east of Leeds.

5. Wisley. Light sandy loam at junction of Bagshot sands and London clay, at R.H.S. Gardens, Wisley, Ripley, Surrey, 120 feet above sea level.

6. Boston, Lincs. Light top soil on heavy bottom.

7. Co. Down. Reclaimed mountain land which had previously grown nothing but bracken. A gravelly loam at Burrenreagh, Castlewellan ; soil as a rule very suitable for potato-growing.

8. Exeter. Dark stiff loam with a clay and gravel subsoil, at Eleve Nursery, Exwick, growing young conifers for past six years.

9. Preston. A hazel loam one year from pasture at Council Farm, Hutton, near Preston, 82 feet above sea level.

10. Shropshire. A medium loam containing a fair quantity of flinty stones. Old pasture bastard trenched early in 1917 at Oswestry.

The following table shows the weight of seed of each variety sent to each station :—

WEIGHT OF " SETS " SENT TO EACH STATION IN LBS.

	Guernsey.	Edinburgh.	Bristol.	Leeds.	Wisley.	Boston Lincs.	Co. Down, I.	Exeter.	Preston.	Salop.	Total.
EARLY VARIETIES.											
Sir J. Llewelyn ..	2¼	2⅛	2½	2⅛	2⅛	2½	2¼	2½	2¼	2⅝	23⅛
Snowdrop (Resistant)	2⅜	2¼	2½	2½	2¼	2½	2¼	2⅝	2⅜	2½	24⅜
Sharpe's Express ..	2⅝	2½	2½	2¾	2½	2½	2¼	2⅝	2⅝	2⅝	25½
Witch Hill	2⅝	2¾	2½	2⅞	2⅞	2½	2⅞	2½	2⅞	2⅜	27
Midlothian Early ..	2⅝	2¾	2¾	2¾	2⅝	2⅞	2⅝	3	2½	2⅞	27⅜
SECOND EARLY VARIETIES.											
British Queen ..	2⅝	2⅞	2½	2⅞	2⅞	2⅝	2⅞	2½	3	2⅝	27⅜
Great Scot	3¾	2¾	3½	2½	2½	3	2¼	3½	2½	3¼	29½
Secundus	2⅝	3½	2⅝	3⅜	3⅝	2⅝	3½	2¾	3⅞	2⅝	31⅛
Burnhouse Beauty ..	2¾	2⅝	2¾	2⅜	2¾	2¾	2⅝	2¾	2⅜	2¾	26½
Dobbie's Favourite ..	2⅞	3	2⅞	2⅝	3⅛	3	2⅞	2⅞	2⅝	2¾	28⅝
MAIN CROP VARIETIES.											
Dobbie's Prolific ..	2¼	3	3¼	2⅞	3⅛	3⅜	2⅞	3	2⅞	3	29⅝
The Provost	2⅝	2¼	2¾	2⅝	2½	2¾	2⅝	2⅝	2¼	2¾	25¾
The Factor	2⅝	2¾	2⅝	3	2⅞	2⅝	2⅝	2¾	2⅝	2¾	27¼
King Edward ..	2⅞	3	2½	3⅜	3¼	2⅜	3⅜	2¾	3¼	2¼	29
The Admiral	2⅞	2⅝	2¾	2⅝	3⅛	2⅞	2⅞	2¾	2⅝	2⅞	28
Kerr's Pink	2½	2¾	2¾	2¾	2¼	2⅝	2⅞	2¾	2½	2½	26¼
Arran Chief	3¼	2½	2½	2⅞	2¾	2½	2¾	2⅞	2⅞	2½	27⅜
Isis	2⅝	2⅛	2⅝	2½	2¼	2⅝	2½	2⅝	2¾	2½	25⅛
White City	3½	3	3⅜	3⅜	3⅛	3¼	3⅛	3⅜	3	3¼	32⅜
The Lochar	2⅞	2½	2½	2⅝	2½	2½	2½	2½	2½	2½	25⅛
											546⅜

Among a lot of detailed information received from the different growers reference must be limited to the following :—

The wet August adversely affected the crop of the late varieties, and so did the dry July, while the dryness of July helped the early varieties to finish off well. Mr. Sowman reports that during the growing period the plants were closely inspected. No variations in foliage of each individual variety could be detected to warrant the marking of any as rogues. Disease was more prevalent in the south than in the north. All crops were weighed as lifted. Both Mr. Veitch, of Exeter, and Professor Barker, of Bristol, speak of rust attacking " Midlothian Early " badly. While there was no rust

on any of the varieties in the lot at Edinburgh, it was rather prevalent in the field crops in Mid and East Lothian in 1917. It is most injurious to the crop, and if it occurs badly again will demand investigation. Many of the varieties gave an average of 4lb. a root, which at 3 feet × 18 inches represents a crop of 18 tons an acre.

The following table shows the total crop at each of the stations and the aggregate yield of each of the varieties at the ten stations :"—

Total crop at the different stations.		Varieties arranged in order of aggregate weight at ten stations.	
	Lb.		Lb.
Guernsey	1,340	1. British Queen.. ..	799
Edinburgh	1,337	2. Sir J. Llewellyn ..	746
Bristol	1,255	3. Dobbie's Prolific ..	668
Leeds	1,238	4. The Provost	650
Wisley	1,218	5. The Factor	643
Boston, Lincs. ..	1,199	6. Snowdrop (Resistant)	614
Co. Down (I.) ..	1,134	7. Sharpe's Express ..	606
Exeter	1,095	8. King Edward ..	601
Preston	976	9. Great Scot	593
Salop	814	10. Witch Hill	585
	11,606	11. The Admiral	576
		12. Kerr's Pink	569
		13. Secundus	567
Total weight of seed planted		14. Arran Chief	532
at the different stations	546⅜	15. Burnhouse Beauty ..	528
Ratio of increase ..	21	16. Isis	498
		17. White City	488
		18. Dobbie's Favourite ..	479
		19. The Lochar	436
		20. Midlothian Early ..	428
			11,606

ADVISORY WORK.

The number of enquiries received through the post during the year was 133 as compared with 205 for the previous year. This falling-off is probably attributable to the increasing effect of the war on the ordinary county work, this view being supported by the nature of the enquiries submitted. There has been a marked reduction in the number of enquiries of the more ordinary character and an increase in those possessing special features of interest or importance under existing conditions. The following table shows the source of the enquiries :—

Gloucester (including Bristol)	24
Hereford	6
Somerset	52
Wiltshire	4
Worcester	16
Counties outside the Bristol Province	31

The latter figure includes enquiries from Devon, which county contributes an annual grant to the Institute.

Certain questions were referred to the Rothamsted Experimental Station and were dealt with by Dr. Russell, whose assistance it is desired to acknowledge.

The more interesting points raised are indicated in the following review of the general nature of the enquiries :—

Horticulture.—Few questions of special interest relating to fruit culture came under notice. Cases of the dropping of fruits after setting, especially of nectarines and peaches, were reported. The failure of raspberries to make satisfactory growth in a plantation which had been continuously cropped with this fruit for several years has been under investigation : no specific cause was found to account for the trouble.

The preservation of fruit and vegetables by various methods has been the subject of numerous enquiries. In addition to the usual methods of bottling, pulping and drying, the use of various preservatives has engaged attention and the value of several of these substances has been examined. Problems connected with jam-making, such as the use of a variety of sugar substitutes for sweetening purposes, the failure of jams to set owing to pectin deficiencies, and

the prevention of mould growth and of fermentation, were frequently dealt with.

Many questions concerning sugar beet cultivation on a small scale and methods of utilising the crop for sweetening purposes and for household jam-making were received.

Diseases of Plants and their Treatment.—The majority of enquiries under this head were concerned with potatoes. None of those in which the ordinary " late blight " was involved showed any features of special interest, but much confusion between this disease and that generally spoken of in the West of England as " potato rust " was exhibited. The latter disease was severe in certain districts both in 1916 and 1917. No specific organism has yet been discovered to be associated with it in this country. The use of home-grown seed and a dry spring and early summer appear to be two important factors favouring its prevalence. The potato spraying campaign was doubtless responsible for several applications for advice on suitable spray fluids for " potato disease," the relative merits of Bordeaux and Burgundy mixture, and the most effective formulæ for those washes. Enquiries on fungoid diseases were relatively few, but the following cases call for particular mention :—

Tomato collar rot, caused by a species of Phytophthora : seedling or young plants are most generally attacked, death quickly ensuing.

A root disease of Belladonna produced by a species of *Phytophthora :* apparently favoured by high nitrogenous manuring.

A bacterial disease of plum trees, hitherto undescribed : the bark of the trunk and main branches is attacked, death following in due course.

Disease of alder wood, due to *Fomes igniarius* and *Polyporus sulphureus :* this wood, required for clog-making, was rendered unfit for the purpose by the fungoid attacks.

The formation of " glassy " potatoes, probably associated with potato " rust " disease.

Among the enquiries relating to insect or acarine pests the following may be mentioned :—

Mites. Vine mite, *Eriophyes vites*, on the vine.

Pear leaf mite, *Eriophyes pyri*, on the apple. It is uncommon to find the apple attacked by this pest.

Epitrimerus pyri on the apple. This appears to be a new disease. The mite attacks apple leaves, producing purplish hairy spots which later become brownish. This and the preceding case occurred in the same garden.

Insects. *Swinthiurids* on potatoes.
Celery fly, *Acidea heraclei*, on celery.
Gout fly, *Chlorops taeniopus*, on
Apple leaf blister moth, *Ornix petiolella*, on the apple.
Buff tip, *Phalera bucephala*, on hazel.
Gooseberry sawfly, *Nematus ribesii*, on gooseberry.
Apple sawfly, *Hoplocampa testudinea*, on apple.
Capsids on apple.

Cider and Perry Making.—The number of enquiries on this subject has been fewer than usual. Most of the subjects have been referred to in previous Reports, but one or two special features may be noted.

Considerable interest in the preparation and use of cider vinegar has been shown owing to the increasing shortage of malt vinegar. Similarly the shortage of sugar has been responsible for enquiries as to suitable sugar substitutes for sweetening or fortifying cider.

The question of the detection of cider diluted by the addition of water has also been raised. Another enquiry concerned the protein content of cider yeast.

Agricultural Chemistry.—The subjects dealt with may be summarised as follows :—

The use of copperas as a substitute for copper sulphate in spraying mixtures.
The manurial requirements of wheat, more particularly the varying need for potash in different soils.
The manurial value of various samples of superphosphate.
The manurial requirements and the cultural methods needed in certain cases of badly cultivated land.
The manurial value of samples of horn shavings.
The potash content and manurial value of ashes of saw mill waste and of tobacco and wood ash.

In addition analyses of a number of soil samples have been made to ascertain manurial requirements.

Miscellaneous Enquiries.—Enquiries have been received on the following points :—

The preservation of broad beans and peas in salt.
The quality of a sample of radish seed.
Materials suitable for covering jars of fish paste to take the place of tin lids.
The eradication of *Crepis taraxacifolia* in meadow land.
The destruction of thistles.
The possibility of sheep dying through arsenical poisoning when turned into an orchard in August which had been sprayed with lead arsenate in spring.

Special Investigations undertaken as a result of Enquiries.—

(1) *The Treatment of Rhizoctonia disease of Asparagus.* This work has been dealt with in detail in another section of this Report.

(2) *Apple Leaf Scorch.* Further observations on this problem have been made. It was not possible, however, to continue the experiments on trees in pots which were started in 1916.

(3) *Apple Fruit Spot Disease.* Work on this subject has been continued, and considerable information as to the fungi occurring in the spots and the conditions favouring their development has been gained.

(4) *Arsenical Poisoning of Land through treatment with Tannery Leather Waste.* A case of infertility of certain land in Worcestershire following on the application of tannery leather waste as a manure was investigated, and it was found that appreciable quantities of arsenic—sufficient to have a definite toxic action on the crops grown—were present in the soil. The source of the arsenic has been traced back to the leather waste. The question of alleviating the arsenic effect is under investigation.

(5) *The Manurial Value of Horsehair Refuse.* This material, obtained from a factory in Somerset, has been for some time utilised as a manure in the neighbourhood with apparently beneficial results, but definite information as to its manurial value was desired. The nitrogen content proved to be high, but there is some doubt as to the extent of its availability owing to the uncertainty of the rate of decomposition of the material after application to the soil. A series of experiments designed to furnish information on this point has therefore been started.

(6) *Tomato Collar Rot.* This serious disease, caused by a species of Phytophthora, has been under investigation, and efforts are being made to trace the cause of the outbreak which regularly appears in certain districts in late winter and early spring and wipes out whole batches of seedlings and of plants somewhat more advanced in growth. It is referred to more fully in another part of the Report.

Potato-spraying Work. At the request of the Food Production Department the general organisation of arrangements for potato spraying in the counties of Somerset, Wiltshire, Gloucestershire, Worcestershire and Herefordshire, was undertaken by the Station. This necessitated more or less continuous work on the subject from the middle of May to the end of July, and entailed a considerable

amount of correspondence. Of the five counties Somerset and Wiltshire undertook schemes of their own to be worked by their county staffs. These appeared satisfactory and no assistance was given to them beyond general information. In Herefordshire the number of small growers (to whom the scheme applied) is very small, and arrangements were made through the Herefordshire Fruit Growers' Association that information as regards machines, material and treatment should be published as widely as possible. In Worcestershire the small growers were approached through their organised societies. Being familiar with spraying work in general they were well capable of taking the necessary steps.

In Gloucestershire, owing to the extreme demands on their time, the county staff required some assistance, and it was in their county that most time was spent.

In this county the following demonstrations in potato spraying were given:—

Gloucester	...	Two demonstrations, including a considerable country district adjoining the city.
Cirencester	...	One demonstration.
Fairford	...	One ,,
Longhope	...	One ,,

Bristol City, being outside the areas served by the county staffs, required special arrangements. Most of the allotments (total 6,000) are grouped under associations, and it was finally arranged that these associations should see to the spraying, making where necessary a reasonable charge for the work.

In addition, however, a few demonstrations were given in allotments not included under such associations, namely:—

Abbots Leigh	...	One demonstration.
Knowle	...	One ,,
Clifton	...	One ,,

Mangel Variety Trials, 1917.

In 1915 the Experiments Committee of the Agricultural Advisory Council for the Bristol Province organised a series of mangel variety trials at a number of centres in the counties constituting the Bristol Province with the object of comparing the selected varieties not only as regards crop but also as regards yield of material food value. The Agricultural Organisers of the counties concerned undertook the arrangements for the cultural side of the trials and the analytical work was carried out at Long Ashton. Since that year Worcestershire has been the only county in the Province in a position to continue the trials: in its case they have been conducted in 1916 and 1917 on similar lines to the original series.

The following report of the 1917 results has been prepared by Mr. R. C. Gaut, M.Sc., Agricultural Organiser for the county named, and its inclusion here is due to his kindness in placing it at the disposal of the Station for publication.

"*Varieties Tested.*—The following varieties were grown :—

	Variety.	Type.
1.	Golden Globe (Garton)	Golden Globe
2.	Golden Tankard (Sutton)	Golden Tankard
3.	Red Globe (Garton)	Red Globe
4.	Red Intermediate (Webb)	Red Intermediate
5.	Lion Intermediate (Webb)	Yellow Intermediate
6.	Prizewinner (Sutton)	Yellow Globe

County Centres.—Arrangements were made to sow four pounds of seed of each of the six varieties at the undermentioned centres in the county.

As in previous seasons the varieties were sown on uniform land and grown in the ordinary course of rotation cropping. The methods of cultivation and manuring were those practised by the farmer and may be regarded as suitable to the different soils and conditions of each locality.

The seed was sown on the ridge excepting at Centre No. 3.

1.—*Mr. D. Ballard, Home Farm, Abberley.*—Soil, a fairly deep strong loam ; sub-soil clay. Previous crop, wheat following clover. Manuring for mangels per acre—farmyard manure 20 tons, fish manure 4 cwts., with nitrate of soda, 1½ cwts., and sulphate of ammonia 1½ cwts. (mixed together and applied as two top-dressings after singling). Date of sowing, 4th May. Date of sampling, 16th October.

2.—*Mr. J. H. Crane, Oakhampton, Stourport.*—Soil, a loam passing into a stronger sub-soil. Previous crop barley, which was grown with farmyard manure. Manuring for mangels per acre—night-soil a light dressing (and after ploughing ½ ton ground lime), peruvian guano 4 cwts. with nitrate of soda 1 cwt. and salt 2 cwts. (mixed together and applied as the top-dressing after singling). Date of sowing, 14th May. Date of sampling, 5th November.

3.—*Mr. F. A. Jackson, Thorn Farm, Inkberrow.*—Soil, a sandy loam passing gradually into a sandy sub-soil overlying rock. Previous crop oats following mangels. Manuring for mangels per acre—farmyard manure 15 tons, superphosphate 3 cwts., sulphate of ammonia 1 cwt., with nitrate of soda ½ cwt. (as a top-dressing after singling). Date of sowing, 5th May. Date of sampling, 26th October.

4.—*Mr. Frank Hickton, Brookfields Farm, Belbroughton.*—Soil, a medium loam passing into a sandy sub-soil. Previous crop wheat, following clover. Manuring for mangels per acre—farmyard manure 15 tons, peruvian guano (12 p.c. ammonia, 22 p.c. phosphates, 2 p.c. potash) with nitrate of soda 1 cwt. and salt 1 cwt. (mixed together and applied as one top-dressing after singling). Date of sowing, 1st May. Date of sampling, 9th October.

5.—*Mr. R. G. Thompson, Parkmore Farm, Hartlebury.*—Soil, a medium to strong loam, sub-soil clay. Previous crop oats, (which received basic slag 5 cwts. and a "special" top-dressing), following oats, (no manure), following potatoes (farmyard manure). Manuring for mangels per acre—farmyard manure 18 tons with nitrate of soda 1 cwt. (as a top-dressing after singling). Date of sowing 27th April. Date of sampling, 29th October.

6.—*Mr. A. J. Tate, The New Farm, Rushock.*—Owing to poor and irregular germination of the seed this centre was abandoned early in the season.

Weather in Worcestershire.—Although the season of 1917 was more congenial to root crops than its predecessor, it was not an ideal mangel year. Wintry weather continued until about the 18th April and the soil was certainly very cold when sowing commenced during the last week of the month. May was marked by heavy rains and thunderstorms, particularly between the 9th and 27th. The hottest period of the year was experienced during the early part of June and this was followed by a dry spell accompanied frequently by cold nights until nearly the middle of July. Strong land got very hard on the surface and rendered singling no easy matter, especially where the mangels had been sown on the flat. The remainder of the growing season was cool and decidedly on the wet side ; there was, in fact, a marked absence of the hot weather periods usually associated with July and August and sometimes with September.

Notes taken during the Growing Season.—The following is a summary of the notes taken on occasions when the centres were inspected during the growing season.

Germination of the seed was much better than in 1916 and a generally uniform plant was obtained. The failure at the Rushock centre cannot be accounted for ; it was general for all the varieties.

Undoubtedly, the cold nights during early summer were not conducive to rapid growth and the plants were a long time in filling the rows. The abundant late summer rains also kept the soil cool ; consequently, there was more tendency for leaf than for root growth and there were no heavy crops nor very large roots.

Golden Globe and Golden Tankard showed a decided improvement on the previous season and at the Oakhampton centre particularly presented excellent plots.

Red Intermediate and Prizewinner were the varieties most favoured for weight at the autumn inspection, with Lion Intermediate and Red Globe following as second choice.

Weighing the Crop and Sampling.—The necessary analytical work was done at Long Ashton. Fifty cores were taken of each variety at the different centres and packed in small tins with grease-proof paper; these were despatched to Bristol without delay.

During sampling the differences in the texture of the different varieties were particularly noticeable. The roots of Golden Globe and Golden Tankard were so firm that it was difficult to extract complete cores without splitting them. Those of Lion Intermediate were, on the other hand, so "fluffy" in character that the cores often broke in the middle during extraction; numbers of the roots were also partially diseased internally—a feature noticed uniformly at all centres. Prizewinner cores also had a tendency to break inthe middle.

With respect to the texture of the other varieties there was nothing of note to report.

Arrangements have also been made for repeating the analyses in the early part of 1918. With this object in view each experimenter has promised to reserve a cart-load of roots of each variety so that the requisite number of cores may be taken.

Percentage Composition of the Roots.—The following is a statement of the Autumn analyses :—

DRY MATTER.

Variety.	Abberley. %	Oakhampton. %	Inkberrow. %	Beltroughton. %	Hartlebury. %
Golden Globe	12·3	13·0	12·8	12·6	13·6
Golden Tankard ..	13·2	12·1	12·5	11·9	13·4
Red Globe	11·7	10·4	11·4	10·3	12·2
Red Intermediate ..	11·07	9·6	10·3	10·1	11·6
Lion Intermediate ..	10·3	9·2	10·3	10·1	11·2
Prizewinner	8·3	9·1	10·1	9·9	10·2

SUGAR.

Golden Globe	6·78	7·63	8·08	7·00	6·92
Golden Tankard ..	7·82	6·58	7·28	6·66	6·43
Red Globe	6·80	5·72	7·06	5·73	6·33
Red Intermediate ..	6·24	5·12	6·10	5·14	5·40
Lion Intermediate ..	5·97	4·38	5·80	6·38	5·56
Prizewinner	5·95	4·39	5·88	5·23	4·80

Results per Acre.—In the succeeding tables the total yield of roots per acre is given for each variety at the different centres; also the total yields per acre of dry matter and sugar as calculated from the percentages given in the preceding tables of Autumn analyses.

1.—Abberley.

Variety.	Weight of Crop. Tons.	Cwts.	Weight of Dry Matter. Cwts.	Weight of Sugar. Cwts.
Golden Globe	29	7	72¼	39¾
Golden Tankard	32	12	86	51
Red Globe	33	19	86½	50¼
Red Intermediate	40	4	89	50¼
Lion Intermediate	39	11	81½	47¼
Prizewinner	39	11	65¾	47

2.—Oakhampton.

Golden Globe	38	14	100½	59
Golden Tankard	40	0	96¾	52¾
Red Globe	40	15	84¾	46½
Red Intermediate	42	8	81½	43½
Lion Intermediate	44	12	82	39
Prizewinner	43	12	89¼	38¼

3.—Inkberrow.

Golden Globe	23	10	60¼	38
Golden Tankard	29	14	74¼	43¼
Red Globe	33	7	76	47
Red Intermediate	32	13	67¼	39¾
Lion Intermediate	36	16	75¾	42¾
Prizewinner	28	1	56¾	33

4.—Belbroughton.

Golden Globe	27	8	69	38¼
Golden Tankard	30	2	71¾	40
Red Globe	34	11	71¼	39½
Red Intermediate	33	10	67¾	34½
Lion Intermediate	30	3	61	38½
Prizewinner	31	7	62	32¾

5.—Hartlebury.

Golden Globe	22	17	62¼	31½
Golden Tankard	23	14	63½	30½
Red Globe	25	2	61¼	31¾
Red Intermediate	26	18	62½	29
Lion Intermediate	23	13	53	26¼
Prizewinner	26	18	55	25¾

Average of the Five Centres.—The figures given below summarise the results at the different centres ; they have been calculated from the five preceding tables. The average figures for the five centres in the previous season are also given for comparison.

Season 1917.

Variety.	Weight of crop. Tons.	Cwts.	Dry Matter. per cent.	cwts.	Sugar. per cent.	cwts.
Golden Globe	28	7	12·86	72¾	7·28	41¼
Golden Tankard	31	4¼	12·62	78½	6·95	43½
Red Globe	34	3	11·20	76	6·33	43
Red Intermediate	35	2½	10·55	73½	5·60	39¼
Lion Intermediate	34	19	10·22	70¾	5·62	38¾
Prizewinner	33	18	9·52	65¾	5·25	35¼

Season 1916.

Golden Globe	25	17	12·70	65¾	7·60	39¼
Golden Tankard	24	2	12·00	58	6·80	32¾
Red Globe	32	1	10·90	69¾	6·20	39¾
Red Intermediate	36	8	10·20	74	5·60	40½
Lion Intermediate	36	5	9·70	70¼	5·30	38¼
Prizewinner	36	10	9·70	70¾	5·20	37¼

Results of the Trials.—The following are the chief points of interest in connection with the 1917 trials, together with notes comparing the results with those of 1916 :—

(1.)—The lower cropping powers of the varieties Golden Globe and Golden Tankard as compared with the other more robust types. The difference in weight per acre between the two groups last season was, however, not so pronounced as in 1916.

(2) The value of types like Red Globe, Red Intermediate, Lion Intermediate and Prizewinner where weight of roots is the primary consideration. The varieties have not individually preserved the same order of merit in the two years, Red Intermediate just taking precedence in 1917.

(3) The richness in percentages of dry matter and sugar of Golden Globe and Golden Tankard and the drop between these and the other varieties. The order as regards quality (with the exception of Golden Tankard at Abberley) is strikingly uniform at all the 1917 centres. The quality factor is, therefore, a well-defined variety characteristic and is only subject to variations slightly above or below the normal for the variety. The order of the varieties in the 1917 table of averages is, as in the 1916 table, the order of merit as regards quality.

(4) The excellent position, with respect to the production of dry matter and sugar per acre of Golden Globe and Golden Tankard in the 1917 table. In this connection the Oakhampton centre stands out pre-eminently, as it has raised the average figures very considerably. When the 1916 results were compiled it seemed doubtful whether the Golden types could approximate in this respect to the more vigorous varieties, but last season's figures indicate that where these latter varieties do not yield a considerably heavier crop of roots the former may approach them or even surpass them as food producers.

(5) The differences in the physical texture of the roots of the several varieties. This character, though well known in practice, was clearly apparent while " coring " the roots for samples. Golden Globe and Golden Tankard were particularly firm, while Lion Intermediate and Prizewinner were much less solid. The physical and analytical characters of the varieties are thus closely correlated."